Dazed and Confused - New Insights in Concussion Evaluation - Active Rehab

Jim Chesnutt, M.D.
OHSU Concussion Program
Orthopaedics & Rehabilitation
Neurology, Family Medicine
Rebound Sports Medicine

OR Governor's Task Force TBI
OCAMP: Co-Director
OHSU TBI Inititiave Co-Chair

Learning Objectives:

- Update on new state laws and policies
- Highlight recent OHSU research and collaborations
- Implement active strategies for concussion recovery
- Become familiar with Return to Learn strategies
- Learn about rehabilitation roles and protocols

OHSU Concussion Center

The NW's most comprehensive, multidisciplinary concussion care center

- Cutting edge research and clinical care
  - Concussion rehab and clinical outcomes
  - Sensory Integration: balance & auditory processing
  - Chronic traumatic encephalopathy(CTE)-tau protein
  - Informatics and clinical guidelines

Yearly TBI Scientific Symposium- research to rehab

Partnerships- academics, community and industry


Brain Injury Rehabilitation Center (BIRC)
WHITWORTH UNIVERSITY
BTF
BRAIN TRAUMA FOUNDATION
LEWIS AND CLARK COLLEGE
EXPLORARE · DISCERE · SOCIARE
1867
GEORGE FOX UNIVERSITY
OREGON SCHOOL ACTIVITIES ASSOCIATION
OSAA
Since 1918
OCAMP
Stanford
REED COLLEGE
cbirt
UNIVERSITY OF OREGON
STATE OF OREGON
1859
OSU
Oregon State
UNIVERSITY
A New VISION
Pacific University Oregon
C
19 05
CONCORDIA UNIVERSITY
NORTHWEST Eye Care PROFESSIONALS
University of Portland
Univ Hawaii
Portland State
UNIVERSITY
ThinkFirst
National Injury Prevention Foundation
Brain Injury Alliance of Oregon

OHSU TBI- PTSD Research to Rehabilitation Scientific Symposium

Dec 13-14, 2019 Dr Steve Broglio, ATC PhD

OREGON HEALTH & SCIENCE UNIVERSITY

OHSU

Collaboration Advancement Award

OREGON CLINICAL + TRANSLATIONAL RESEARCH INSTITUTE

School of Medicine

Research Roadmap

U.S. Department of Veterans Affairs

OHSU TBI Initiative

Dr. Jim Chesnutt, SM, Ortho Rehab, FM, Neuro
Dr. George Keepers, Chair of Psychiatry
Dr Nathan Selden, Vice chair Neurosurgery

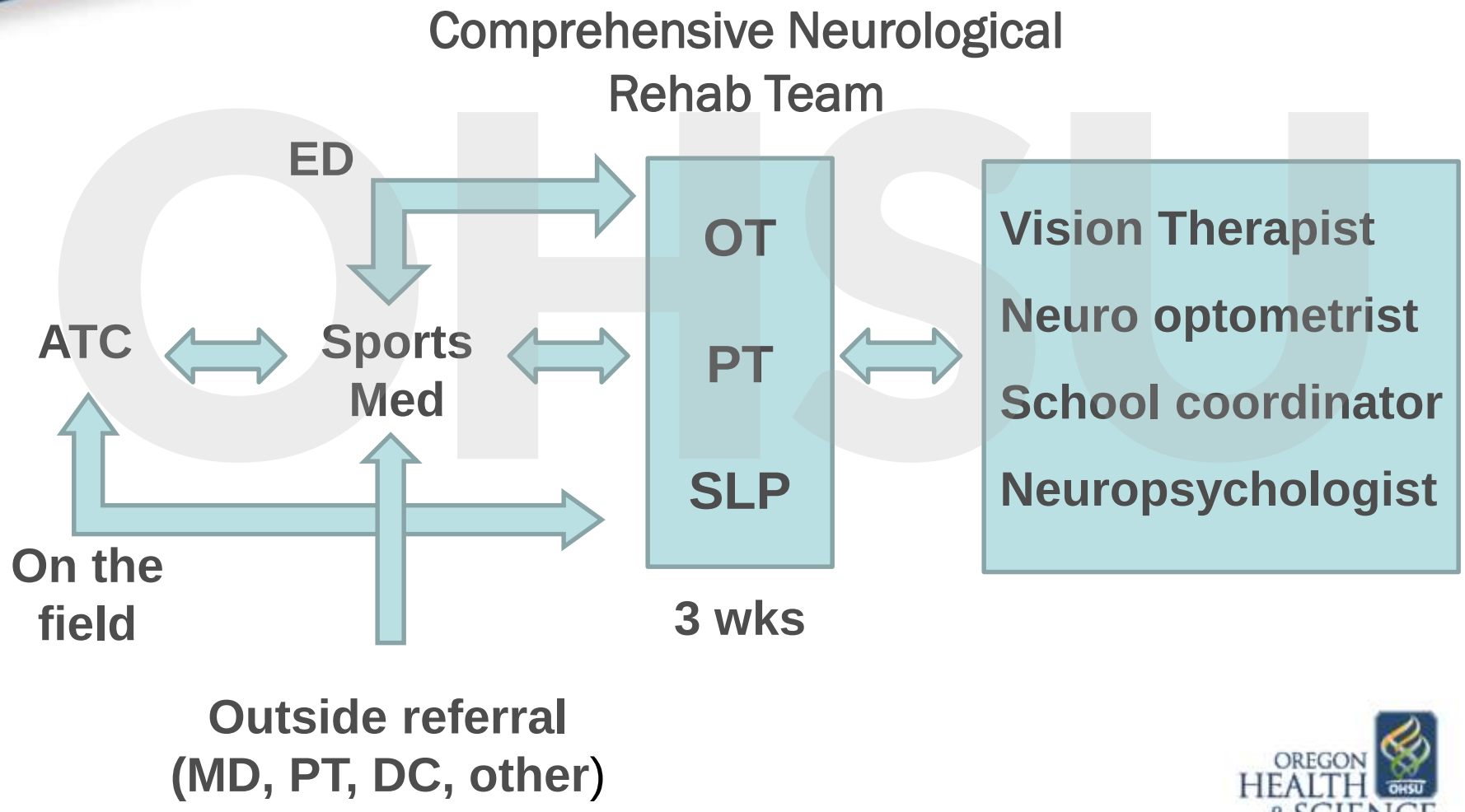
- Over 150 clinicians and researchers
- Research on basic science pathophys & imaging
- Clinical research: trauma, balance, education
- Multidisciplinary teams, inpt, outpt, outreach
- VA Collaboration, auditory processing, neuro trauma, PTSD, research, rehab protocols
- Medical Informatics, EBM, policy

OHSU Concussion Management

- Pre-season Impact baseline testing
  - Can do whole team or individuals
- Athletic trainers on- field and in injury clinic
- Post –concussion evaluations
  - Physician and ATC evaluations & Impact testing
- Concussion Rehabilitation Team
  - PT, Vestibular/ENT, SLP/ cognitive,OT/vision
- Severe/Chronic: Neuropsych, Neuro, NSurg

Sport Concussion Support Group (student/family)

Interdisciplinary approach: OHSU Model



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Concussions: The Problem

- We now realize concussions occur more often than previously thought
- Young athletes are at risk for serious short-term and long-term problems
- There is much variation in the knowledge of Health Care Providers managing concussed athletes
- New and emerging technologies will lead to a continuing evolution of care

Concussions:

The Oregon Plan

State-wide concussion management program involving all high schools

- Establish state-wide physician network
- Uniform evaluation and management protocol
- Consultation service for coaches, athletes, parents, and physicians
- ImPACT baseline suggested for contact and collision sport athletes

Oregon Concussion Awareness and Management Program (OCAMP)

Multi-disciplinary group across the state:

Educators, Physicians, Neuropsychologists, Certified athletic trainers, Rehab Therapists

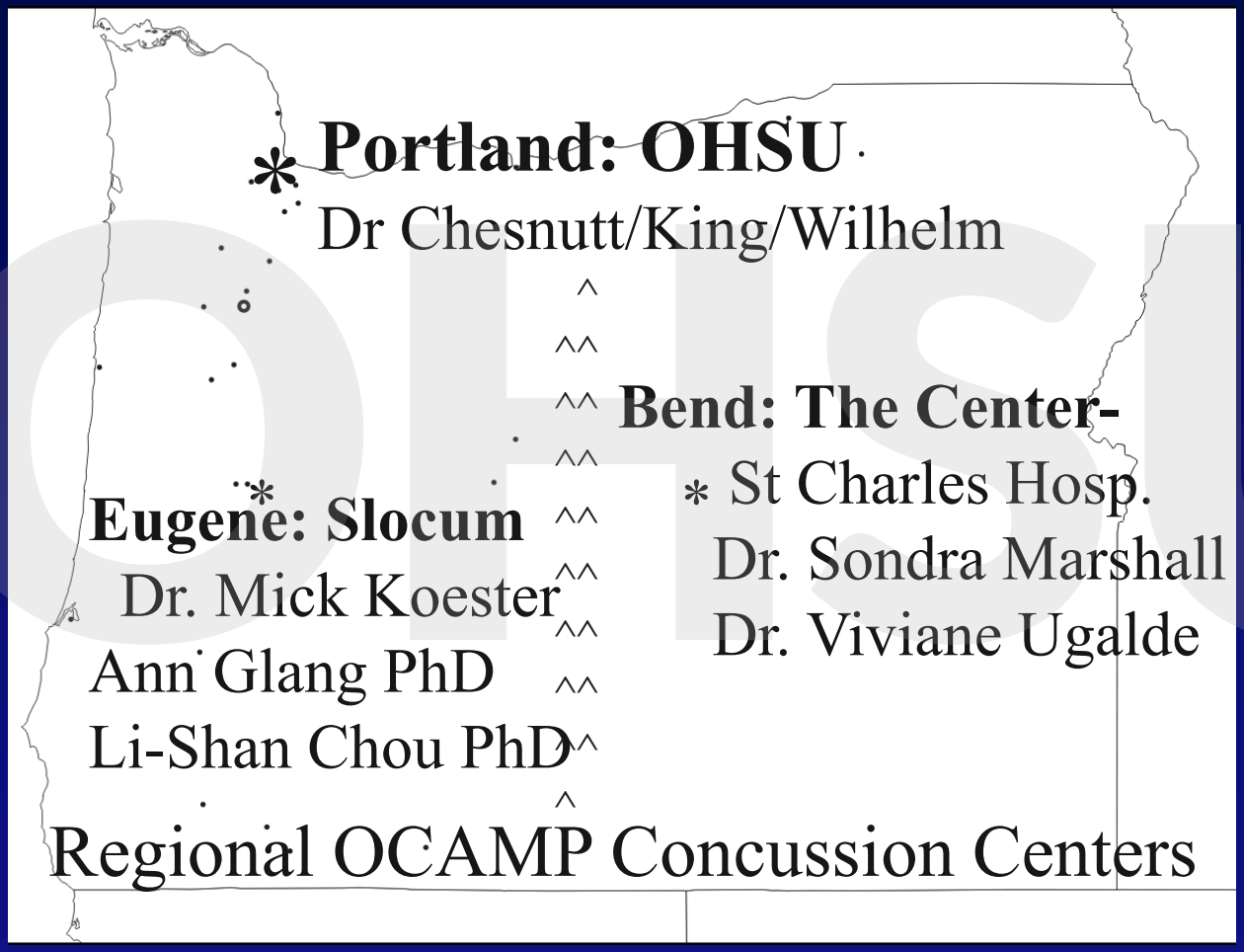
Brain Injury Association of Oregon

Athletic Directors(OADA),

Center for Brain Injury Research and Teaching

Representatives from OSAA , OR Dept of Ed.

Concussions: The Oregon Plan



Each helps "oversee" programs at the "satellite" sites and help local doctors/trainers care for their own athletes

Max's Law: Sports Concussion
(SB 348- April 2009, 1st one passed!)

Max Condradt is an OR brain- injured athlete hurt in football.

- No return-to- play the same day as concussion
- Medical release needed to return to play
- Yearly coach concussion education required
  - Free for coach : www.osaa.org/healthandsafety/concussion.asp
- Effective: July 2009

Max's Law - Sports Concussion SB 348

Left to right: David Kracke, Max Conradt, Governor Ted Kulongoski, Tootie Smith, Sherry Stock

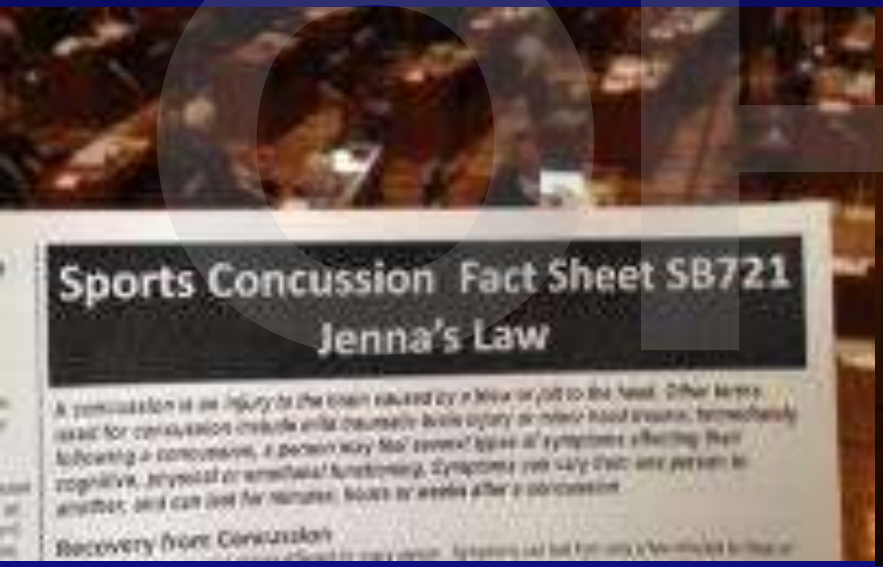
Max's Law: The 4 R's

1. **RECOGNIZE:**
   - all coaches must receive annual training in recognizing the symptoms of concussion.
2. **REMOVE**:
   - no same day return to play
3. **REFER** :
   - must be evaluated by a properly trained medical professional.
4. **RETURN :**
   - all symptoms resolved, graded return to play over about one wk and a medical release has been obtained

Zachery Lystedt Law
Washington HB 1824 5-14-2009

- Youth athletes who are suspected of sustaining a concussion or head injury be removed from play. "When in doubt, sit them out"
- School districts to work with the Washington Interscholastic Activities Association (WIAA) to develop information and policies on educating coaches, youth athletes and parents about the nature and risk of concussion, including the dangers of returning to practice or competition after a concussion or head injury.
- All student athletes and their parents/guardians sign an information sheet about concussion and head injury prior to the youth athlete's initiating practice at the start of each season.
- Youth athletes who have been removed from play receive written medical clearance prior to returning to play from a licensed health-care provider trained in the evaluation and management of concussion.

New 2013 Oregon Bill
Concussions in Club sports
Jenna Sneva, ski racer, >12 concussions
Jenna's Law



What's new in 2018:

SB 217- Add naturopath/ Chiro/ ~~AT~~ / PT to clear mTBI

OHSU to provide concussion education for state law

OCAMP

Oregon Concussion Awareness and Management Program

Max's Law: Concussion Management Implementation Guide

for School Administrators

RECOGNIZE :: REMOVE :: REFER :: RETURN

PACE Property and Casualty Coverage for Education

OREGON DEPARTMENT OF EDUCATION

cbirt

OREGON SCHOOL BOARDS ASSOCIATION

Concussion Management Team:

Healthcare professional, Physician, Neuropsychologist, Athletic Trainer, Nurse Practitioner, Physician Assistant, Coach, HS Counselor, Teachers and Parents

IMPLEMENT CONCUSSION MANAGEMENT PLAN

TO ADDRESS AND ASSESS PHYSICAL & COGNITIVE NEEDS OF ATHLETE

(Share plan with coach, school, athlete & parent)

Follow a Graduated Return to Exertion & Academics

Follow-up concussion management assessment

- Consider formalized support if symptoms last more than 2-3 months:
  - Contact OR TBI Team
  - 504 Plan or referral to SPED

When symptom free and released by Concussion Management Team proceed to full activity level

GOVERNOR'S TASK FORCE ON TRAUMATIC BRAIN INJURY

REPORT ON FINDINGS AND RECOMMENDATIONS

OUR VISION

The vision of the Governor's Task Force on TBI is that Oregon will establish and maintain a comprehensive, public-private system of coordinated care and supports for individuals with brain injury of all ages, severity levels, and backgrounds that facilitates maximum community engagement and quality of life.

GOVERNOR'S TASK FORCE ON TRAUMATIC BRAIN INJURY: EXECUTIVE ORDER NO. 13-02, 2013

REPORT ON FINDINGS AND RECOMMENDATIONS

August 2016

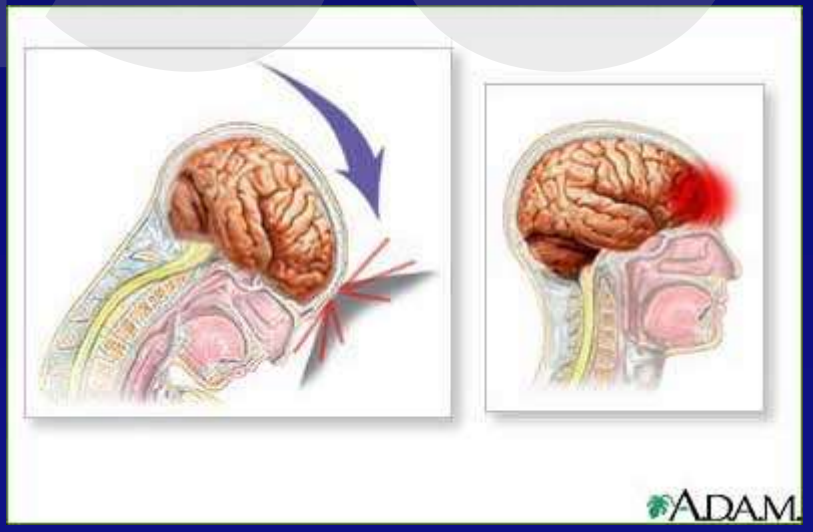
RECOMMENDATIONS AT A GLANCE

1. Increase educational outreach
2. Establish a TBI Clinical Registry
3. Establish a centralized "road map" of services and resources
4. Establish a statewide program of care coordinators
5. Develop an equitable system of care and services
6. Develop a communication system to improve coordination across agencies
7. Establish sustainable, equitable funding mechanisms
8. Establish the Governor's Traumatic Brain Injury Coordinator and Advocate in the Office of the Governor


adidas

What is a Concussion?

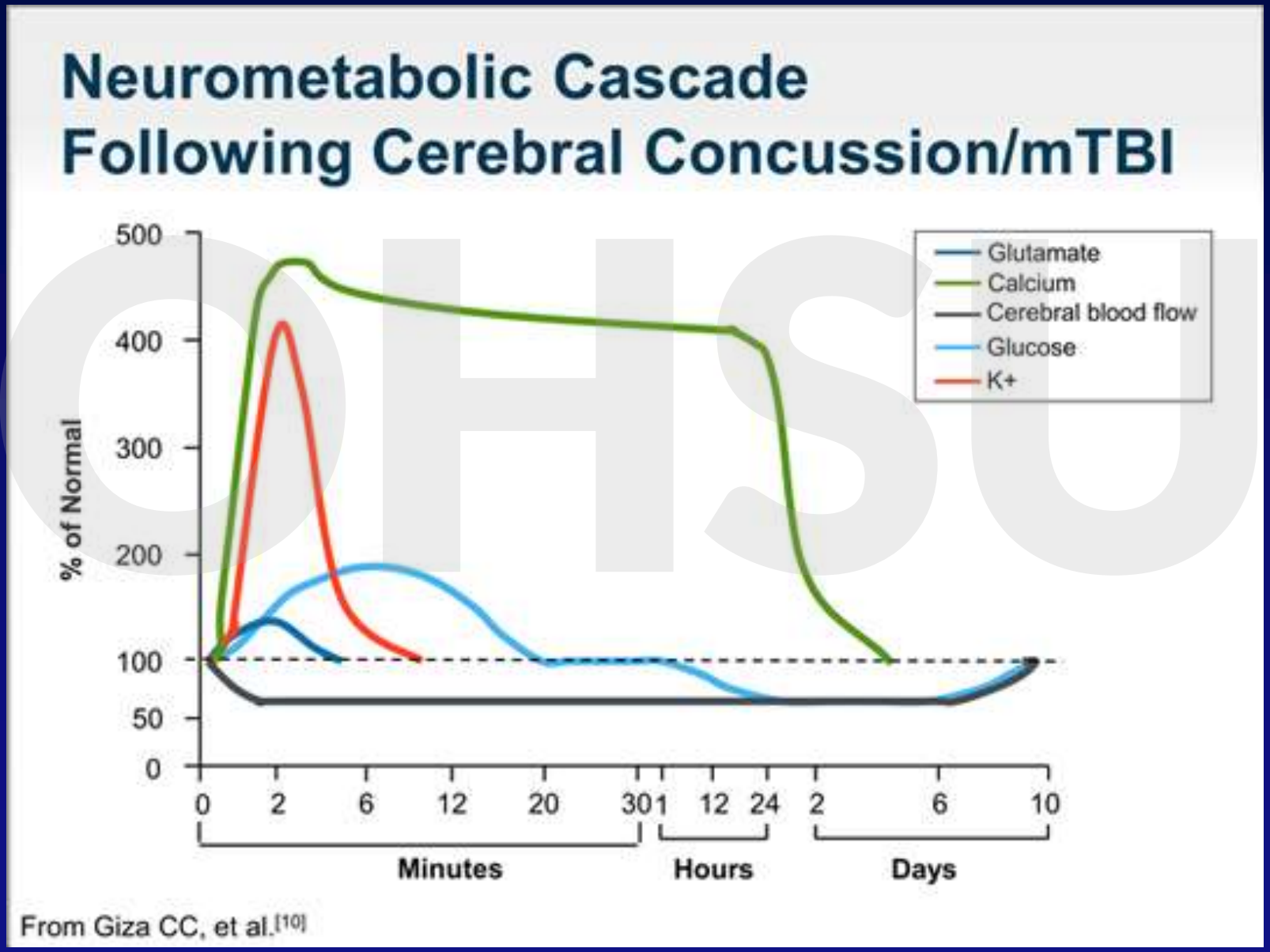
- A concussion is a **mild traumatic brain injury** that interferes with normal function of the brain
- Evolving knowledge- “dings” and “bell ringers” are brain injuries- no such thing as a *mild concussion*
- Loss of consciousness **is not common** in concussion(<90%)
- (GCS 13-15)



Concussion Mechanics/ Biology

- Aceleration/ Deceleration
- Linear/ rotational
- Neurometabolic energy crisis
- Decreased cerebral blood flow, glucose
- Abnormalities Glutamate, K, Na, Ca, etc
- Endocrine, neurochemical abnormalities
- Neuron injury and Axon shearing
- Prefrontal motor cortex, corpus callosum and central processing network

Metabolic Crisis in Brain post TBI-



Concussion: Helmet to helmet hit

Newer Data High School RIO 2015-6

Injury rate per 10,000 player exposures competition

- Boy's Football-- 10.5
- Girls' soccer 9.2
- Girls' lacrosse 8.6
- Boys' Ice Hockey – 7.6
- Boys' Wrestling – 5.5
- Girls' basketball 5.5
- Boys' Lacrosse – 5.0
- Boys' Soccer – 4.2
- Girls' field hockey 4.1
- Boys' basketball 3.9

Soccer-Football and Concussion
World Soccer and Science Conf -2016

- Estimate 270 million players world wide
- 27 mil in N America
- 40 % concussions for arm/ elbow to head
- 60% contact related to headers but not headers themselves
- Female more ground contact
- Heading *may* be related to brain injury
  - Usually at least 1000yr worse if over 1800?

Concussion Symptoms

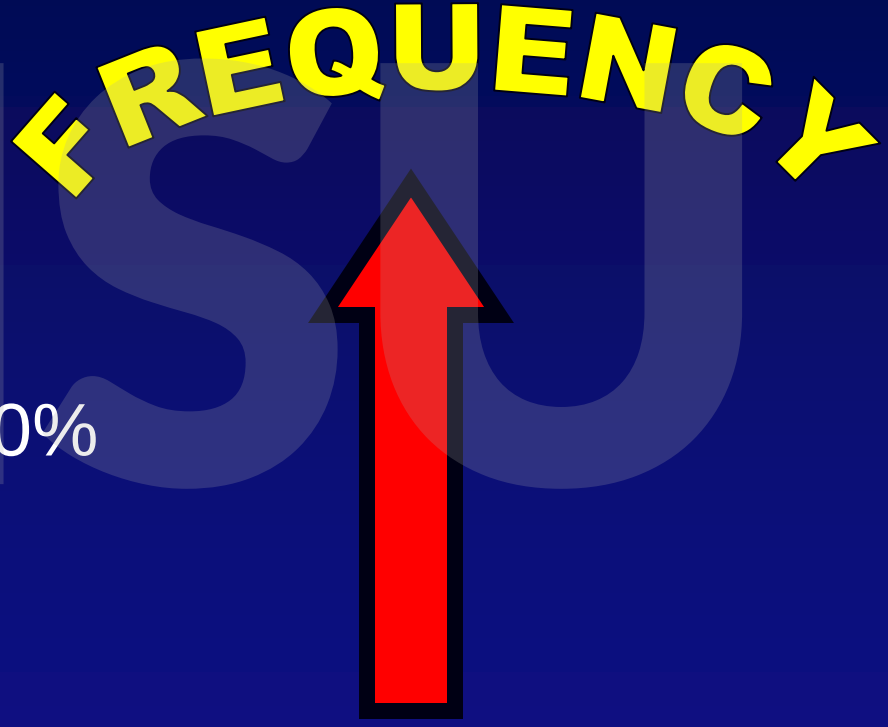
variable for each individual in terms of type, intensity and duration:

- **Symptoms:** (eg, headache, foggy or emotional) l
- **Physical signs** (eg, loss of consciousness, amnesia, neurological deficit)
- **Balance impairment** (eg, gait unsteadiness)
- **Behavioral changes** (eg, irritability)
- **Cognitive impairment** (eg, slowed reaction times)
- **Sleep/wake disturbance** (eg, somnolence,drowsiness)

Berlin 2016. McCrory P, *et al. Br J Sports Med* 2017.

Symptoms

- Headache 75%
- Blurred vision 75%
- Dizziness 60%
- Nausea 54%
- Memory/ confusion 40-60%
- Double vision 11%
- Noise sensitivity 4%
- Light sensitivity 4%
- Loss of consciousness 5-10%



Carney, Ghajar et al 2014

New Definition
evidence- based systematic review

1.) a change in brain function;

2.) following a force to the head(+/- hit)

-a potentially concussive event;

3). may (or may not) be accompanied by temporary LOC;

4.) identified in awake individuals; and

5.) includes measures of neurologic and cognitive dysfunction. (Carney, Ghajar et al., 2014.)

Concussion -consistent and prevalent diagnostic indicators

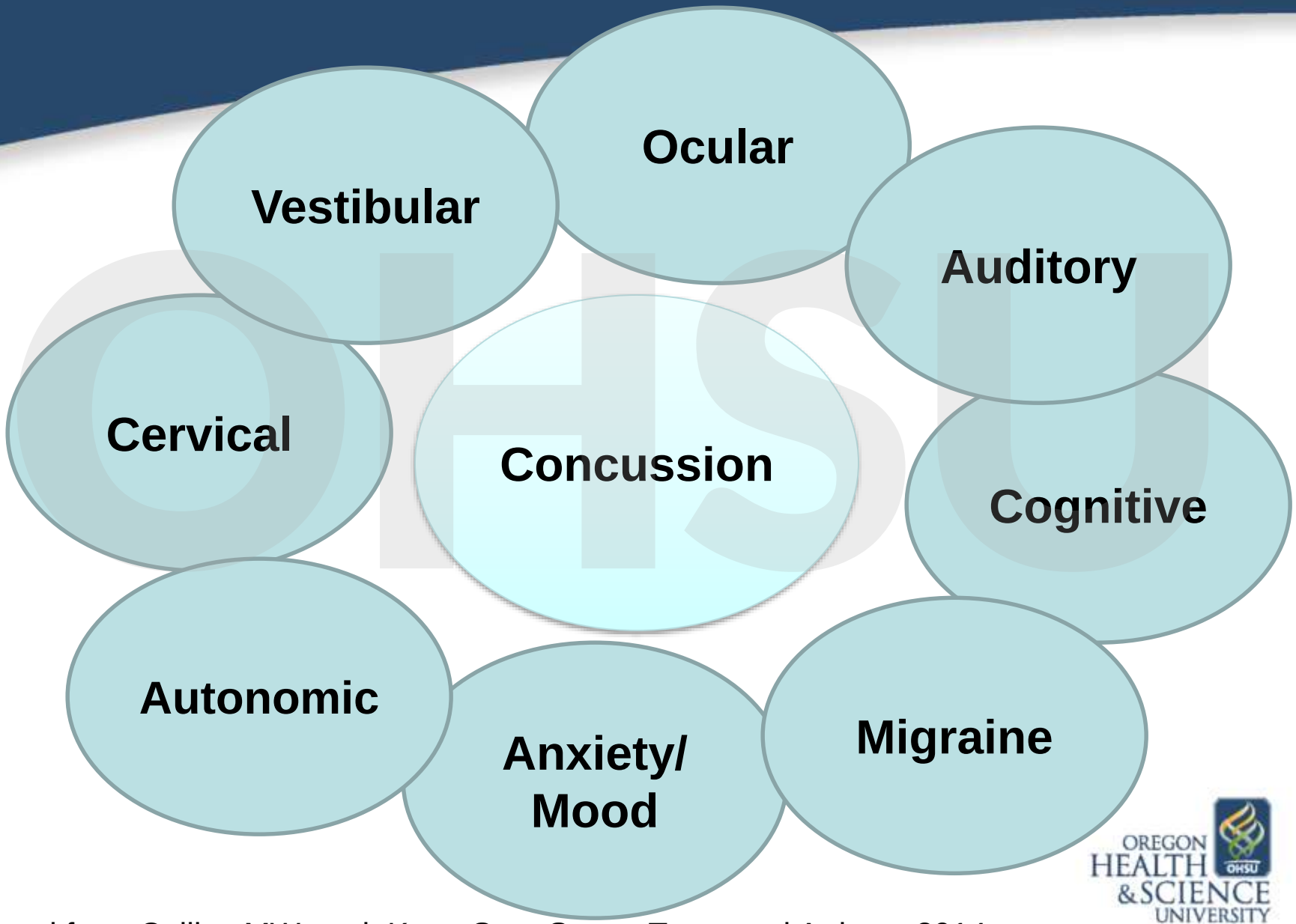
1.) observed and documented disorientation or confusion immediately after the event;

2.) impaired balance within 1 day after injury;

3.) slower reaction time within 2 days after injury; and /or

4.) impaired verbal learning and memory within two days after injury. (Carney,Gjahar, et al., 2014.)

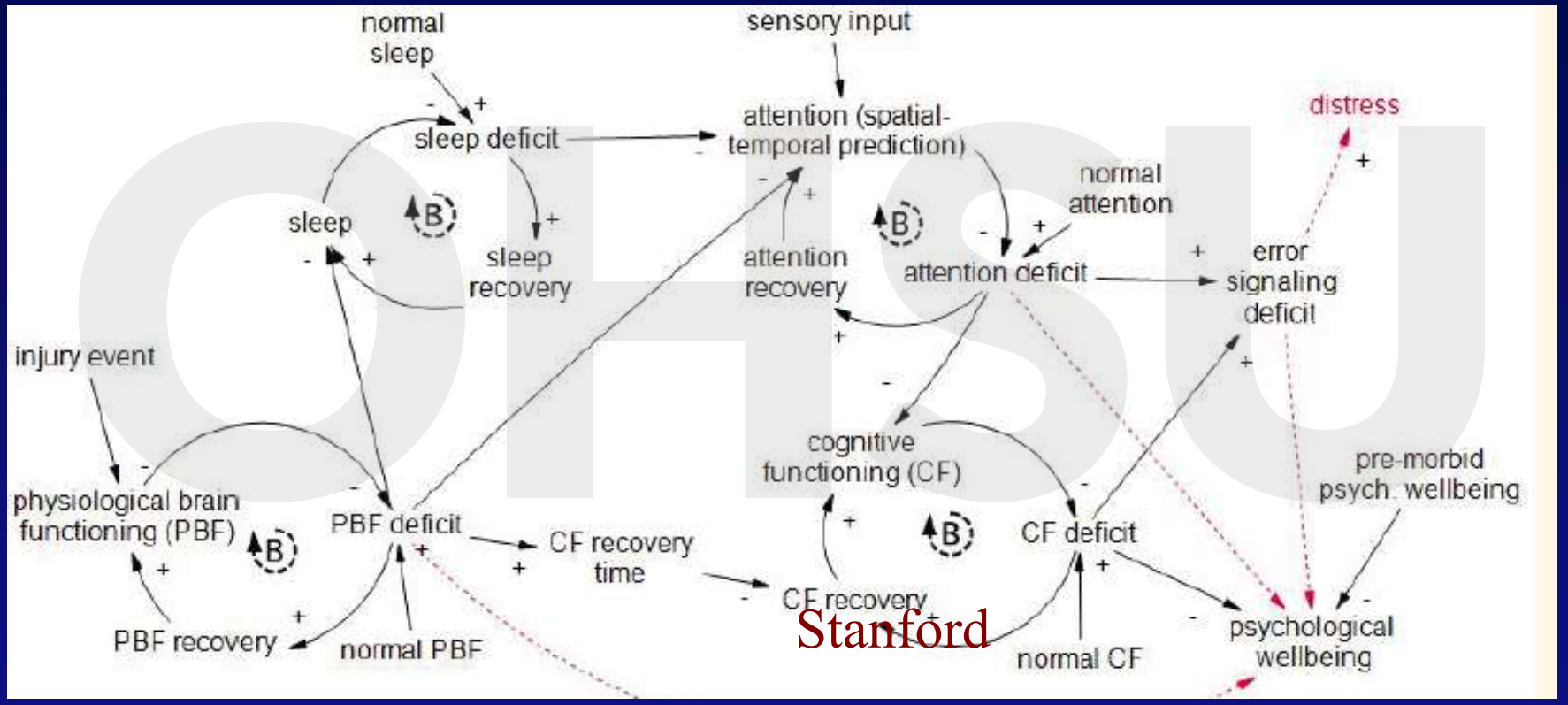
Interdisciplinary Approach: Concussion Symptoms



Adapted from Collins MW et al; Knee Surg Sports Traumatol Arthosc 2014

Dynamic Model of Concussion

work started in 2013 on scale model and causal loop diagram model and finally papers published 2017 and 2018



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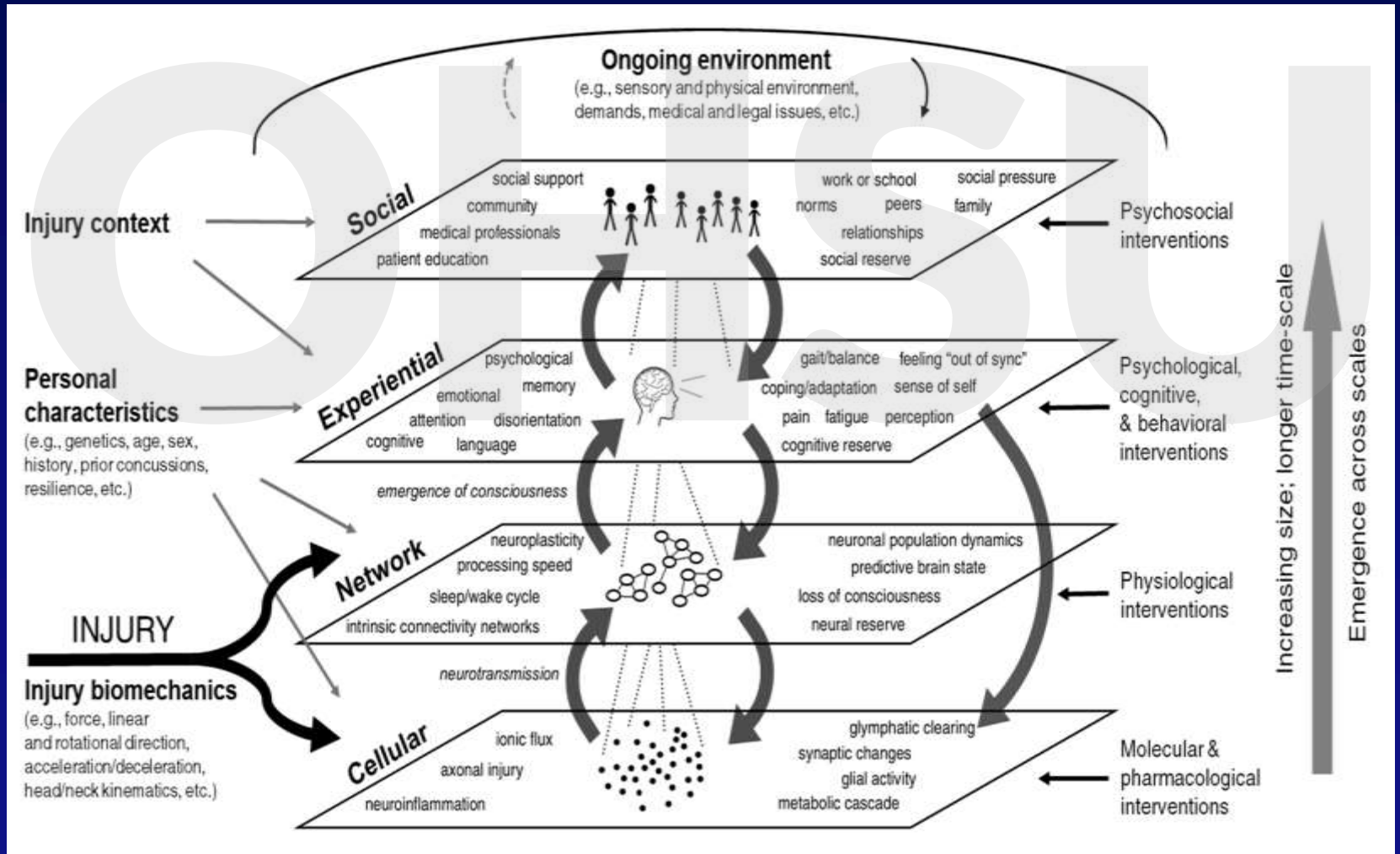
BTF BRAIN TRAUMA FOUNDATION

Portland State UNIVERSITY

Concussion As a Multi-Scale Complex System: An interdisciplinary Synthesis of Current Knowledge

Erin S. Kenzie, Elle L. Parks, Erin D. Bigler, Miranda M. Lim, James C. Chesnutt, and Wayne Wakeland

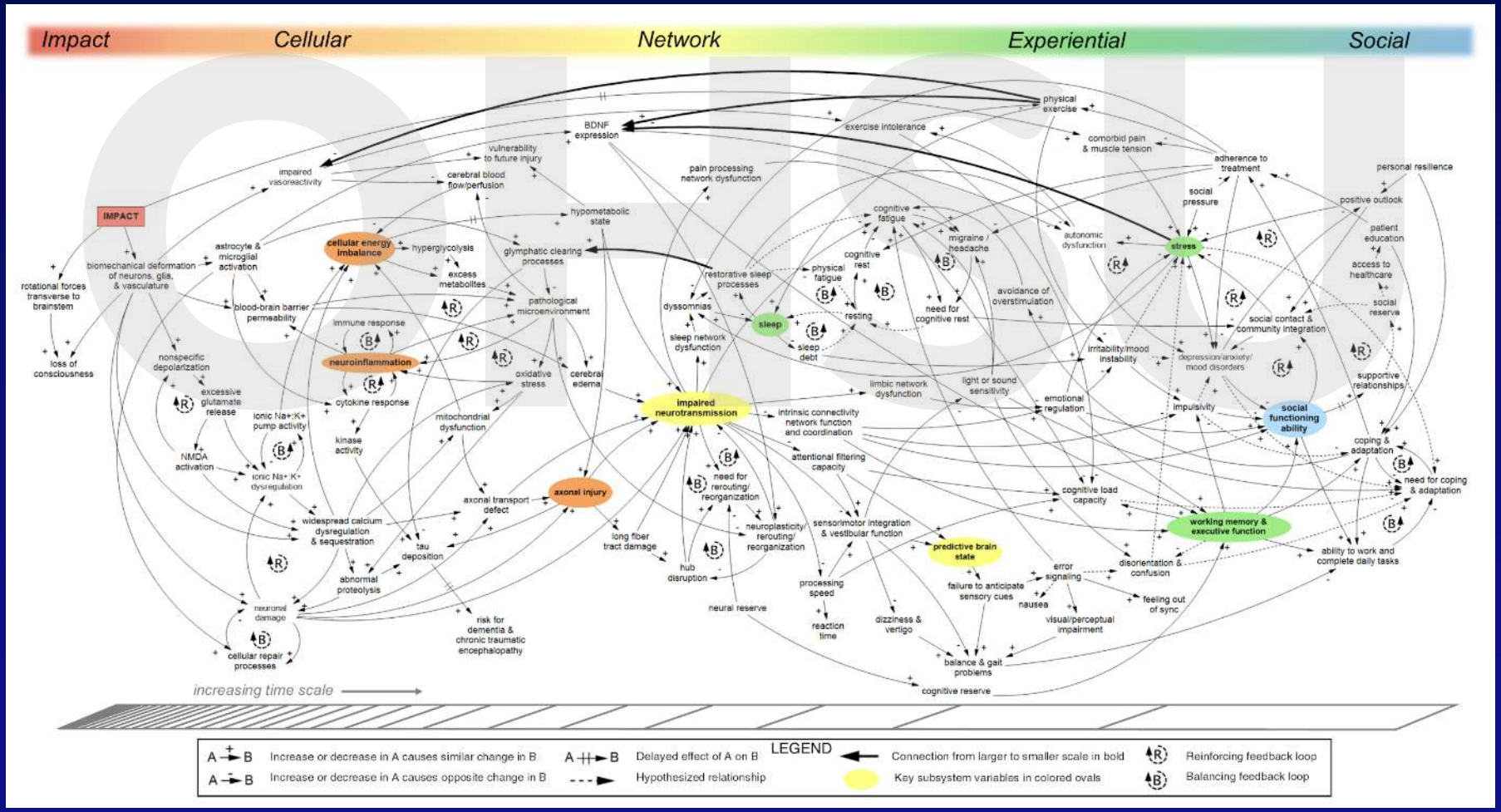
Frontiers in Neurology September 2017 | Volume 8 | Article 513



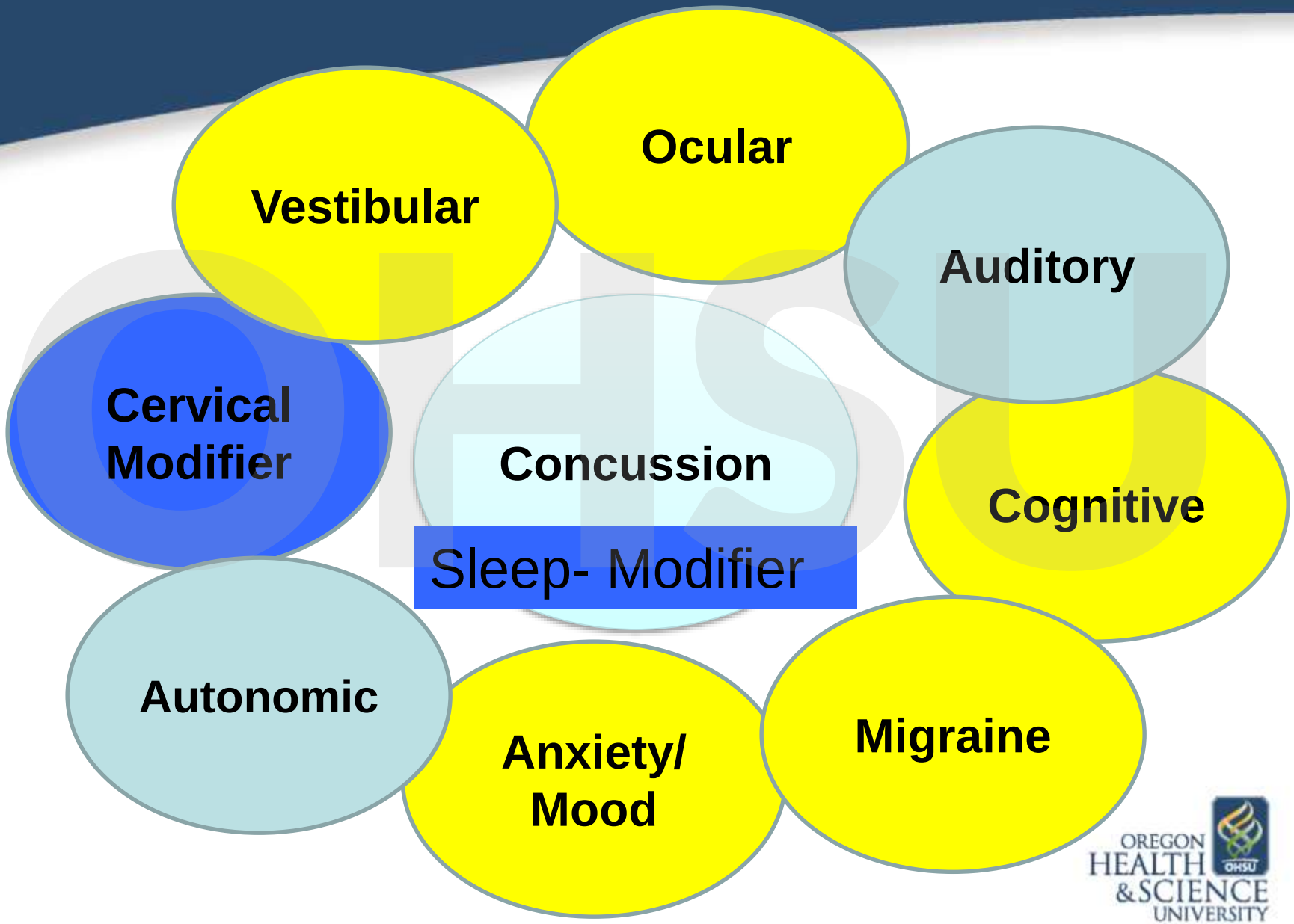
The Dynamics of Concussion: Mapping Pathophysiology, Persistence, and Recovery With Causal-Loop Diagramming

Benzie ES, Parks EL, Bigler ED, Wright DW, Lim MM, Chesnutt JC, Hawryluk GWJ, Gordon W and Wakeland W (2018). Front. Neurol. 9:203.

www.Dynamicsofconcussion.com



Concussion Subtype Development



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Concussion Guidelines Step 2: Evidence for Subtype Classification

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(Continued on next page)

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Received, February 14, 2019.
Accepted, June 23, 2019.

BACKGROUND: Concussion is a heterogeneous mild traumatic brain injury (mTBI) characterized by a variety of symptoms, clinical presentations, and recovery trajectories. By thematically classifying the most common concussive clinical presentations into concussion subtypes (cognitive, ocular-motor, headache/migraine, vestibular, and anxiety/mood) and associated conditions (cervical strain and sleep disturbance), we derive useful definitions amenable to future targeted treatments.

OBJECTIVE: To use evidence-based methodology to characterize the 5 concussion subtypes and 2 associated conditions and report their prevalence in acute concussion patients as compared to baseline or controls within 3 d of injury.

METHODS: A multidisciplinary expert workgroup was established to define the most common concussion subtypes and their associated conditions and select clinical questions related to prevalence and recovery. A literature search was conducted from January 1, 1990 to November 1, 2017. Two experts abstracted study characteristics and results independently for each article selected for inclusion. A third expert adjudicated disagreements. Separate meta-analyses were conducted to do the following: 1) examine the prevalence of each subtype/associated condition in concussion patients using a proportion, 2) assess subtype/associated conditions in concussion compared to baseline/uninjured controls using a prevalence ratio, and 3) compare the differences in symptom scores between concussion subtypes and uninjured/baseline controls using a standardized mean difference (SMD).

RESULTS: The most prevalent concussion subtypes for pediatric and adult populations were headache/migraine (0.52; 95% CI = 0.37, 0.67) and cognitive (0.40; 95% CI = 0.25, 0.55), respectively. In pediatric patients, the prevalence of the vestibular subtype was also high (0.50; 95% CI = 0.40, 0.60). Adult patients were 4.4, 2.9, and 1.7 times more likely to demonstrate cognitive, vestibular, and anxiety/mood subtypes, respectively, as compared with their controls ($P < .05$). Children and adults with concussion showed significantly more cognitive symptoms than their respective controls (SMD = 0.66 and 0.24; $P <$ .001). Furthermore, ocular-motor in adult patients (SMD = 0.72; $P <$ .001) and vestibular

Concussion in the Media

- Baseline neuropsych testing of Pro Athletes in NFL, NHL, Baseball and other sports
- Higher incidence (3X) of depression if >3 concussions in Pro athletes in some studies
- Risk of premature dementia
- Possible brain damage
  - Brain lesion : *tau protein* deposition
  - Similarities to Alzheimer's/Parkinson's
  - Higher risk if certain genes (APO E -4)
  - CTE chronic traumatic encephalopathy

CTE- Tau deposition

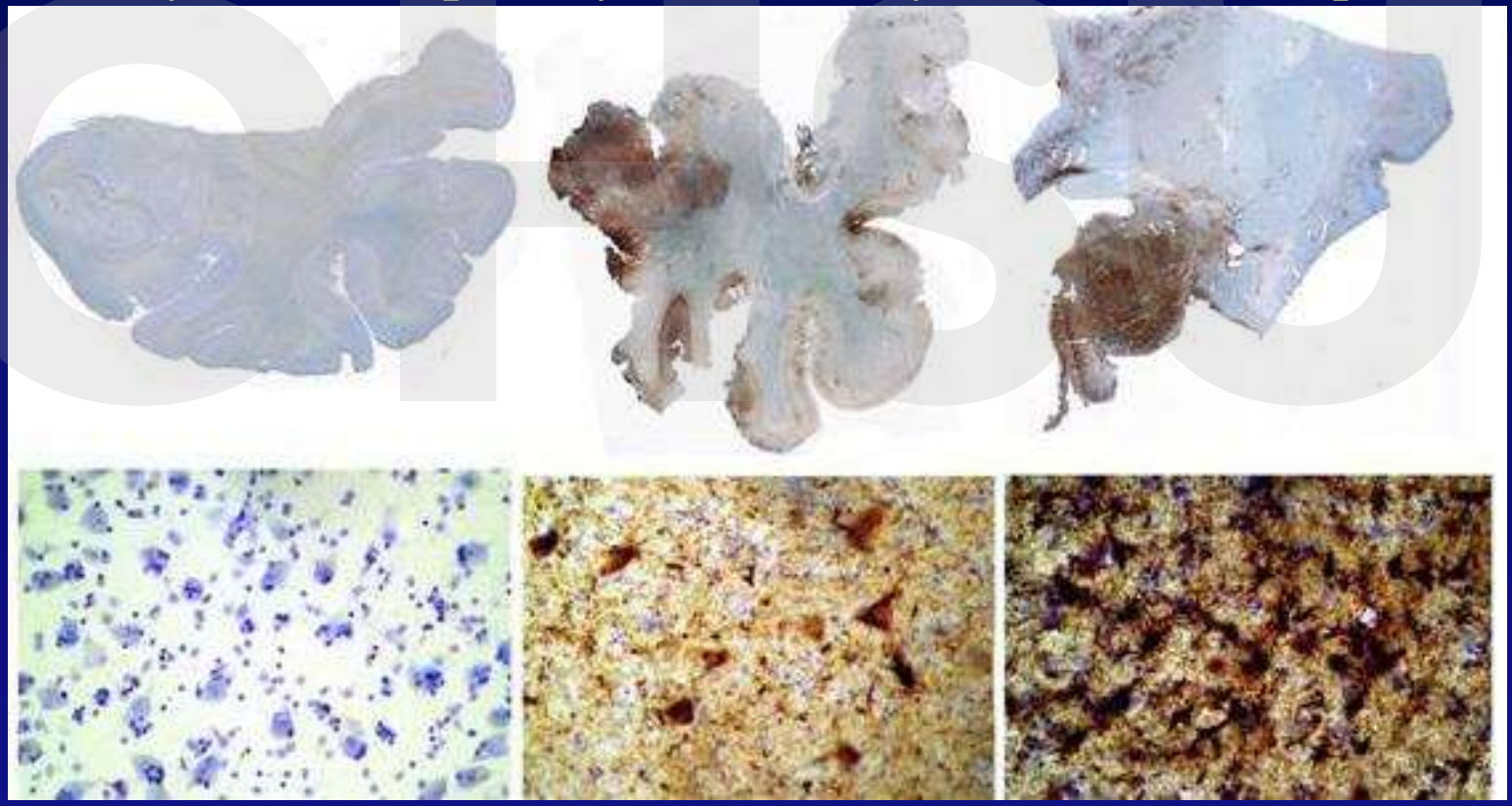
perivascular and frontal/temporal sulci

assoc with repetitive TBI but no direct cause

Recent article suggests possible very high rate in FB??

JAMA. 2017;318:360–370.

Recent 50 yr follow up study HS FB very low rate neuro problems



Boston Univ CTE Center normal

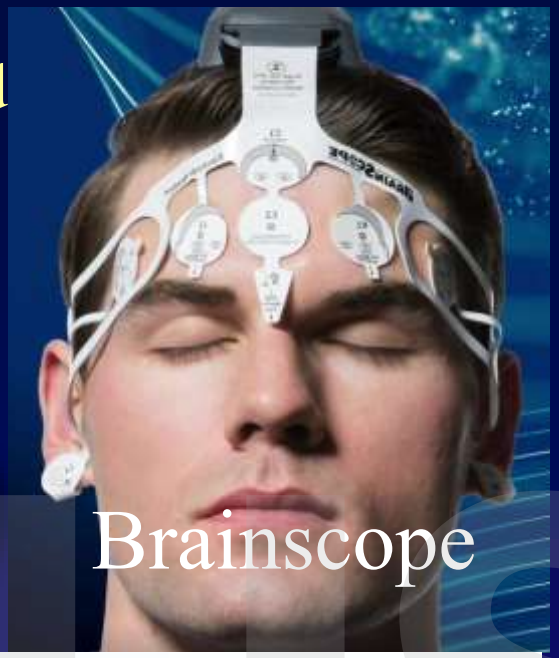
Tau tangles

Tau plaques

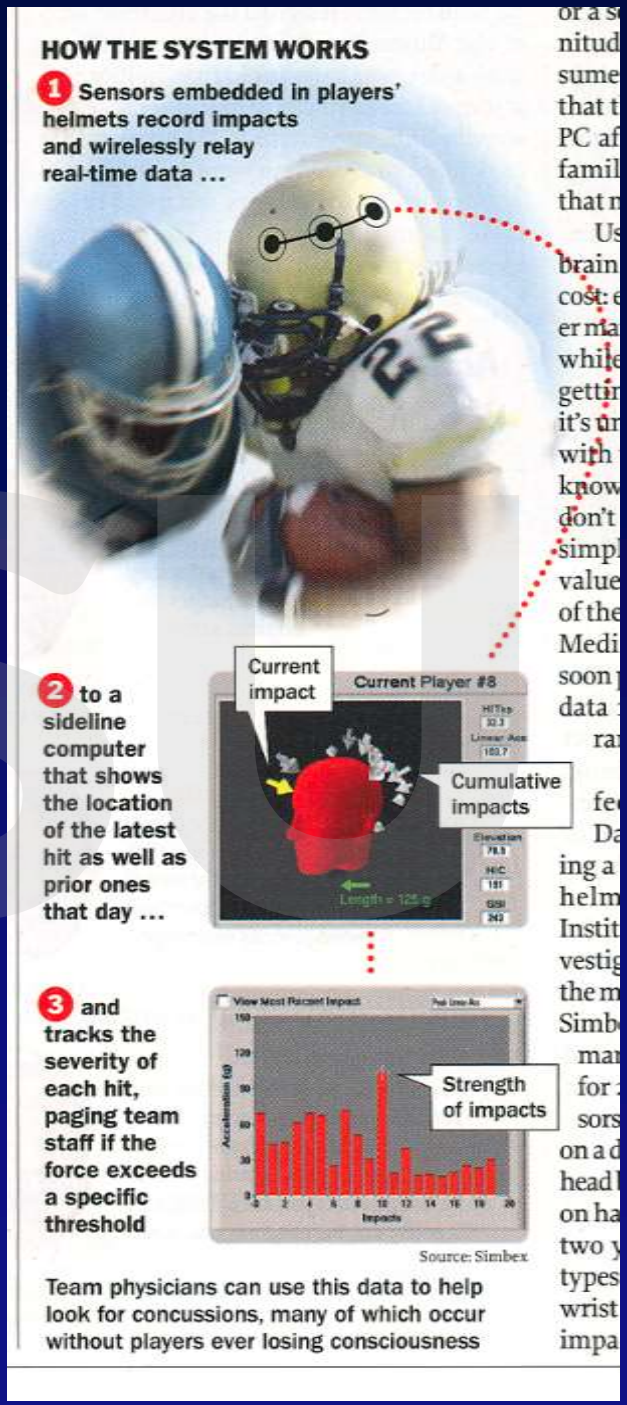
NY Time, LA Times, etc, 2/18

FDA approves first blood test that can help diagnose a concussion ,

what????It actually does not diagnose concussion at all.. Only brain bleeds and structural brain injury



Brainscope




BJSM
Injury Prevention & Health Protection
4th International Consensus Conference on Concussion in Sport (Zurich 2012)
FIFA
BMJ | Journals

AAN 2013 Concussion Guideline

http://www.neurology.org/content/80/24/2250.full.pdf+html

SPECIAL ARTICLE

AMERICAN ACADEMY OF NEUROLOGY.

Summary of evidence-based guideline update: Evaluation and management of concussion in sports

Report of the Guideline Development Subcommittee of the American Academy of Neurology

Christopher C. Giza, MD*
Jeffrey S. Kutcher, MD*
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Correspondence to American Academy of Neurology:

ABSTRACT

Objective: To update the 1997 American Academy of Neurology (AAN) practice parameter regarding sports concussion, focusing on 4 questions: 1) What factors increase/decrease concussion risk? 2) What diagnostic tools identify those with concussion and those at increased risk for severe/prolonged early impairments, neurologic catastrophe, or chronic neurobehavioral impairment? 3) What clinical factors identify those at increased risk for severe/prolonged early postconcussion impairments, neurologic catastrophe, recurrent concussions, or chronic neurobehavioral impairment? 4) What interventions enhance recovery, reduce recurrent concussion risk, or diminish long-term sequelae? The complete guideline on which this summary is based is available as an online data supplement to this article.

Methods: We systematically reviewed the literature from 1955 to June 2012 for pertinent evidence. We assessed evidence for quality and synthesized into conclusions using a modified Grading of Recommendations Assessment, Development and Evaluation process. We used a modified Delphi process to develop recommendations.

Results: Specific risk factors can increase or decrease concussion risk. Diagnostic tools to help identify individuals with concussion include graded symptom checklists, the Standardized Assessment of Concussion, neuropsychological assessments, and the Balance Error Scoring System. Ongoing clinical symptoms, concussion history, and younger age identify those at risk for postconcussion impairments. Risk factors for recurrent concussion include history of multiple concussions, particularly within 10 days after initial concussion. Risk factors for chronic neurobehavioral impairment include concussion exposure and *APOE* ε4 genotype. Data are insufficient to show that any intervention enhances recovery or diminishes long-term sequelae postconcussion. Practice recommendations are presented for preparticipation counseling, management of suspected concussion, and management of diagnosed concussion.

Neurology® 2013;80:2250–2257

Published 2107 - newest guidelines!!

Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

Paul McCrory,[1] Willem Meeuwisse,[2] Jiří Dvorak,[3,4] Mark Aubry,[5] Julian Bailes,[6] Steven Broglio,[7] Robert C Cantu,[8] David Cassidy,[9] Ruben J Echemendia,[10,11] Rudy J Castellani,[12] Gavin A Davis,[13,14] Richard Ellenbogen,[15] Carolyn Emery,[16] Lars Engebretsen,[17] Nina Feddermann-Demont,[18,19] Christopher C Giza,[20,21] Kevin M Guskiewicz,[22] Stanley Herring,[23] Grant L Iverson,[24] Karen M Johnston,[25] James Kissick,[26] Jeffrey Kutcher,[27] John J Leddy,[28] David Maddocks,[29] Michael Makdissi,[30,31] Geoff Manley,[32] Michael McCrea,[33] William P Meehan,[34,35] Sinji Nagahiro,[36] Jon Patricios,[37,38] Margot Putukian,[39] Kathryn J Schneider,[40] Allen Sills,[41,42] Charles H Tator,[43,44] Michael Turner,[45] Pieter E Vos[46]

McCrory P, et al. Br J Sports Med 2017

PREAMBLE

The 2017 Concussion in Sport Group (CISG) consensus statement is designed to build on the principles outlined in the previous statements[1–4] and to develop further conceptual understanding of sport-related concussion (SRC) using an expert consensus-based approach. This document is devel-

articles were screened by the expert panels for the Berlin meeting. The details of the search strategies and findings are included in each of the systematic reviews.

The details of the conference organisation, methodology of the consensus process, question development and selection on expert panellists and

Sport Concussion Assessment Tool (SCAT5)

Sideline Evaluation

STEP 2: OBSERVABLE SIGNS

Witnessed ☐ Observed on Video ☐

Lying motionless on the playing surface	Y	N
Balance / gait difficulties / motor incoordination: stumbling, slow / laboured movements	Y	N
Disorientation or confusion, or an inability to respond appropriately to questions	Y	N
Blank or vacant look	Y	N
Facial injury after head trauma	Y	N

STEP 3: MEMORY ASSESSMENT MADDOCKS QUESTIONS[2]

"I am going to ask you a few questions, please listen carefully and give your best effort. First, tell me what happened?"

Mark Y for correct answer / N for incorrect

What venue are we at today?	Y	N
Which half is it now?	Y	N
Who scored last in this match?	Y	N
What team did you play last week / game?	Y	N
Did your team win the last game?	Y	N

Note: Appropriate sport-specific questions may be substituted.

Also GCS, 13-15, neck exam

STEP 2: SYMPTOM EVALUATION

The athlete should be given the symptom form and asked to read this instruction paragraph out loud then complete the symptom scale. For the baseline assessment, the athlete should rate his/her symptoms based on how he/she typically feels and for the post injury assessment the athlete should rate their symptoms at this point in time.

Please Check: ☐ Baseline ☐ Post-Injury

Please hand the form to the athlete

	none	mild		moderate		severe	
Headache	0	1	2	3	4	5	6
"Pressure in head"	0	1	2	3	4	5	6
Neck Pain	0	1	2	3	4	5	6
Nausea or vomiting	0	1	2	3	4	5	6
Dizziness	0	1	2	3	4	5	6
Blurred vision	0	1	2	3	4	5	6
Balance problems	0	1	2	3	4	5	6
Sensitivity to light	0	1	2	3	4	5	6
Sensitivity to noise	0	1	2	3	4	5	6
Feeling slowed down	0	1	2	3	4	5	6
Feeling like "in a fog"	0	1	2	3	4	5	6
"Don't feel right"	0	1	2	3	4	5	6
Difficulty concentrating	0	1	2	3	4	5	6
Difficulty remembering	0	1	2	3	4	5	6
Fatigue or low energy	0	1	2	3	4	5	6
Confusion	0	1	2	3	4	5	6
Drowsiness	0	1	2	3	4	5	6
More emotional	0	1	2	3	4	5	6
Irritability	0	1	2	3	4	5	6
Sadness	0	1	2	3	4	5	6
Nervous or Anxious	0	1	2	3	4	5	6
Trouble falling asleep (if applicable)	0	1	2	3	4	5	6
Total number of symptoms:							of 22
Symptom severity score:							of 132
Do your symptoms get worse with physical activity?						Y	N
Do your symptoms get worse with mental activity?						Y	N
If 100% is feeling perfectly normal, what percent of normal do you feel?							

If not 100%, why?

COGNITIVE & PHYSICAL EVALUATION

Cognitive assessment

Standardized Assessment of Concussion (SAC)[4]

Orientation (1 point for each correct answer)

What month is it?	0	1
What is the date today?	0	1
What is the day of the week?	0	1
What year is it?	0	1
What time is it right now? (within 1 hour)	0	1
Orientation score		of 5

Immediate memory

List	Trial 1	Trial 2	Trial 3	Alternative word list		
elbow	0 1	0 1	0 1	candle	baby	finger
apple	0 1	0 1	0 1	paper	monkey	penny
carpet	0 1	0 1	0 1	sugar	perfume	blanket
saddle	0 1	0 1	0 1	sandwich	sunset	lemon
bubble	0 1	0 1	0 1	wagon	iron	insect
Total						

Immediate memory score total of 15

Concentration: Digits Backward

List	Trial 1	Alternative digit list		
4-9-3	0 1	6-2-9	5-2-6	4-1-5
3-8-1-4	0 1	3-2-7-9	1-7-9-5	4-9-6-8
6-2-9-7-1	0 1	1-5-2-8-6	3-8-5-2-7	6-1-8-4-3
7-1-8-4-6-2	0 1	5-3-9-1-4-8	8-3-1-9-6-4	7-2-4-8-5-6
Total of 4				

Concentration: Month in Reverse Order (1 pt. for entire sequence correct)

Dec-Nov-Oct-Sept-Aug-Jul-Jun-May-Apr-Mar-Feb-Jan	0	1
Concentration score		of 5

ImPACT® Clinical Report

Mark

Exam Type	Baseline	Post-concussion	Post-concussion	Post-concussion	Post-concussion	Post-concussion
Date Tested	09/21/2004	10/08/2004	10/12/2004	10/15/2004	10/19/2004	10/27/2004
Last Concussion		10/07/2004	10/07/2004	10/07/2004	10/07/2004	10/07/2004
Exam Language	English	English	English	English	English	English
Test Version	2.2.729	2.2.729	2.2.729	2.2.729	2.2.729	2.2.729
Composite Scores *						
Memory composite (verbal)	93 75%	**66** 1%	**57** <1%	**63** <1%	87 55%	88 55%
Memory composite (visual)†	70 23%	**41** <1%	**49** 1%	**47** <1%	**55** 3%	66 12%
Visual motor speed composite	45.88 85%	46.38 86%	**40.13** 65%	**38.93** 57%	45.85 85%	41.90 72%
Reaction time composite	0.54 46%	0.60 22%	**0.66** 6%	0.54 46%	**0.62** 15%	0.54 46%
Impulse control composite	8	14	10	16	10	11
Total Symptom Score	0	**14**	3	1	0	0

* Scores in **bold** type indicate scores that exceed the Reliable Change Index score (RCI) when compared to the baseline score. However, scores that do not exceed the RCI index may still be clinically significant. Percentile scores, if available, are listed in small type. Please consult your ImPACT User Manual for more details.

The Canadian Head CT rule

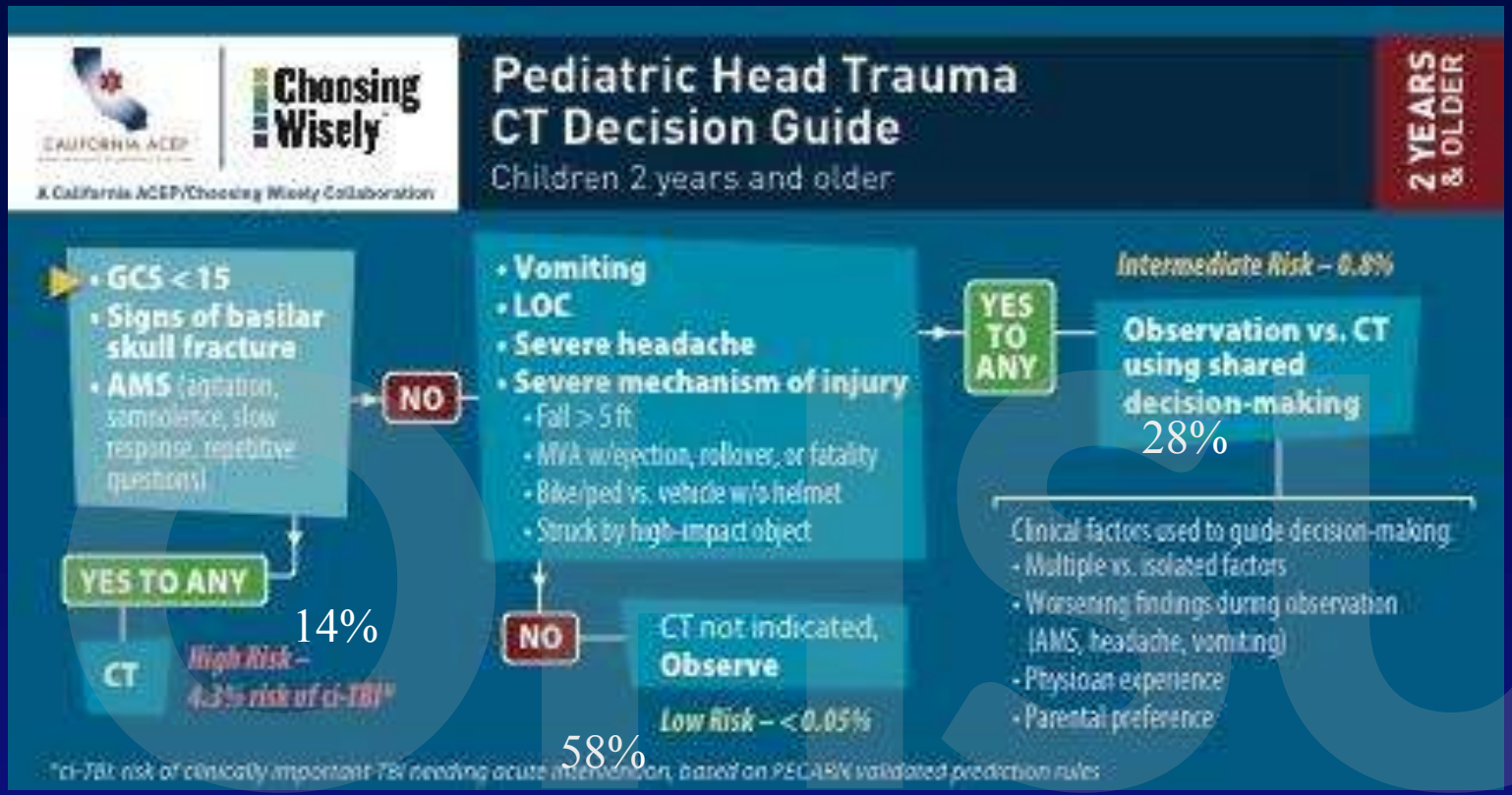
100% sensitive abnormalities that need neurosurgery.

Major Criteria:

- 1.)GCS < 15 at 2 hours post-injury; 2.)Suspected open or depressed skull fracture; 3.) Any sign of basilar skull fracture; 4.) Blood in the middle ear(hemotympanum), or around eyes (raccoon eyes) or back of head(Battle's sign) or cerebral spinal fluid drainage from the nose/ ears); 5.)vomiting (≥ 2 episodes); 6.) Age ≥ 65.

Minor Criteria:

- 1.)Retrograde Amnesia to the Event ≥ 30 minutes; 2.)"Dangerous" Mechanism; 3.)Pedestrian struck by motor vehicle; 4.)Occupant ejected from motor vehicle; 4.)Fall from > 3 feet or > 5 stairs. (Stiell et al. 2001).



PEDIATRIC EMERGENCY CARE APPLIED RESEARCH NETWORK

PECARN CT rule

PECARN CT Rule

Pediatric Emergency Care Applied Research Network

- GCS <15
- Signs of basilar skull fx
- AMS-agitation, somnolence, slow response,repetive questions

YES-
14% positive

Needs CT scan

High risk 4.3% of clnically signif TBI needing acute intervention

NO->

- Vomiting
- LOC
- Severe Headache
- Severe mechanism of injury- fall> 5 ft, MVA ejection, rollover, fatality, high speed, bike crash no helmet

YES to any-> 28%

NO- 58%

CT not Needed

Observe

Low risk <0.05%

Observe vs CT

Intermediate risk 0.8%

Depends on worsening, doctor experience, family concern

Brain Imaging in Acute TBI

- The decision rule-predicting positive CT
  - 100% sensitive (picks up all problems)
  - 46% specific (picks up more unrelated problems)
  - 13.8 % positive if meet criteria
  - All negative if no criteria

Balance screening after concussion

- Balance assessment recommendations in 2009
- Now required for NCAA sports

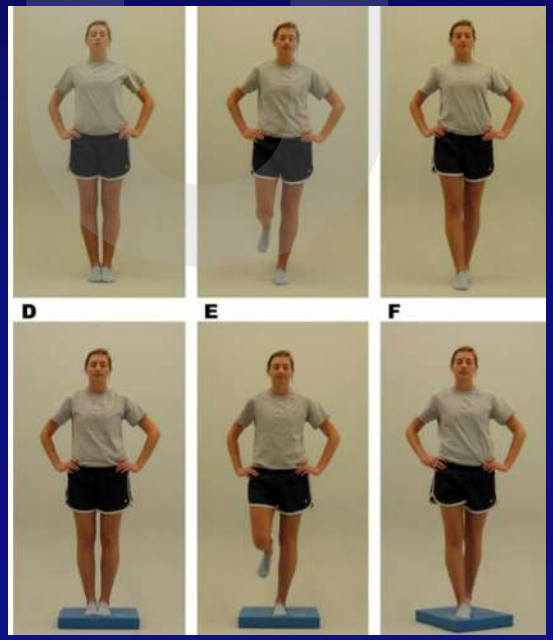
- BESS (modified) –balance error scoring system
- count errors - can be variable

- Sensitivity 34%–64% to detect mTBI

- Balance reportedly resolves after 3-5 days
  But may be due to insensitive testing

**Need better balance tests- goal to find more sensitive test that can be easily done

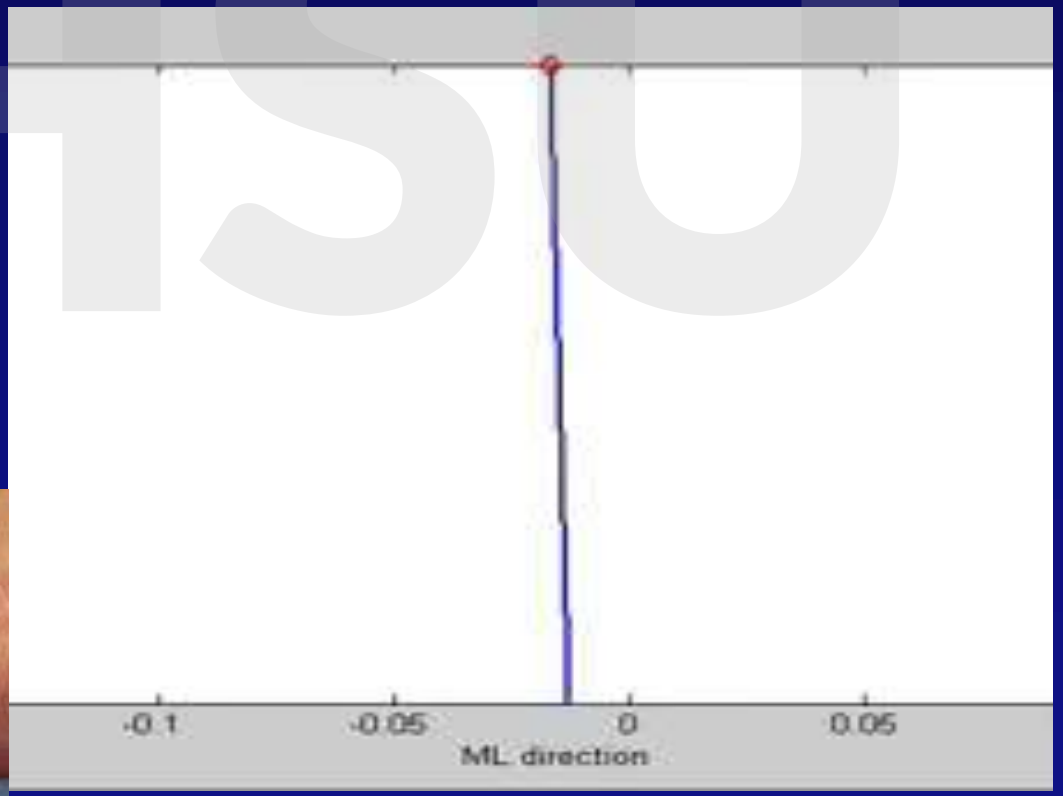
Many investigators trying objectify balance better.



(Zurich 2008; McCrory 2009, Guskiewicz 2001, Finnoff 2009, King 2013, Giza 2013)

Instrument the BESS using an inertial sensor

New portable, wearable and wireless technology



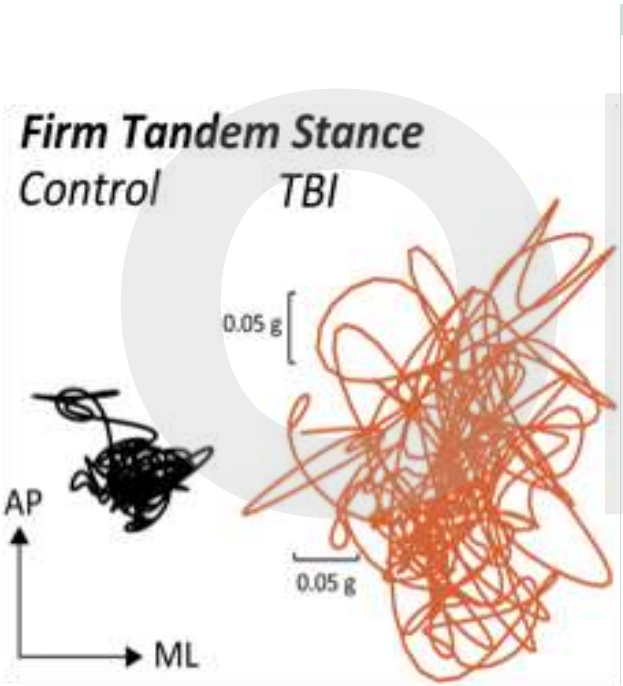
Inertial sensors:

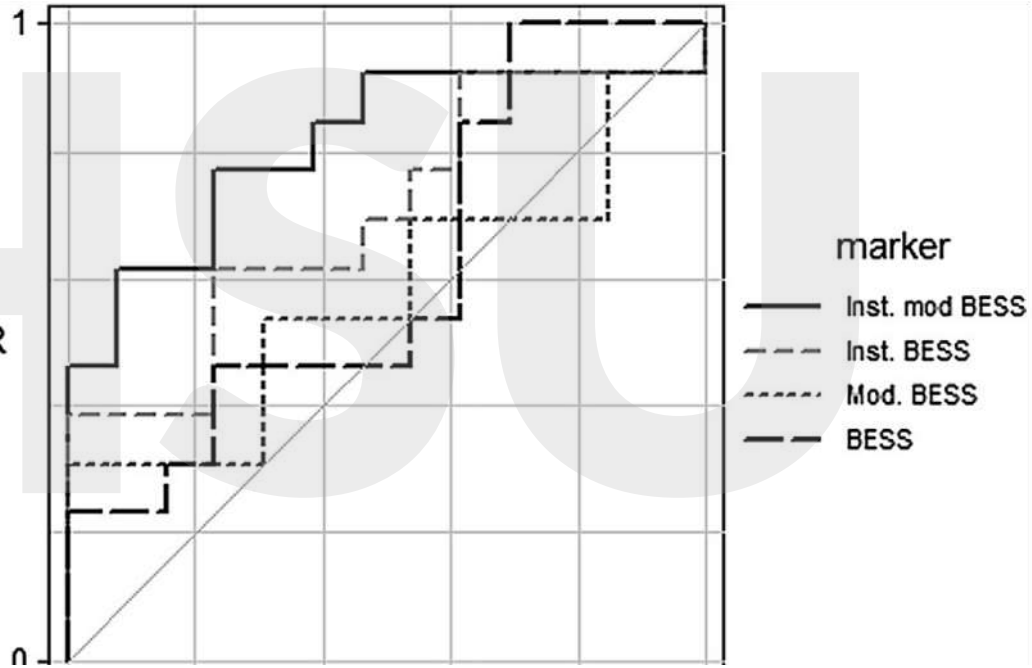
similar to force plate

-Portable

-Automatic analysis

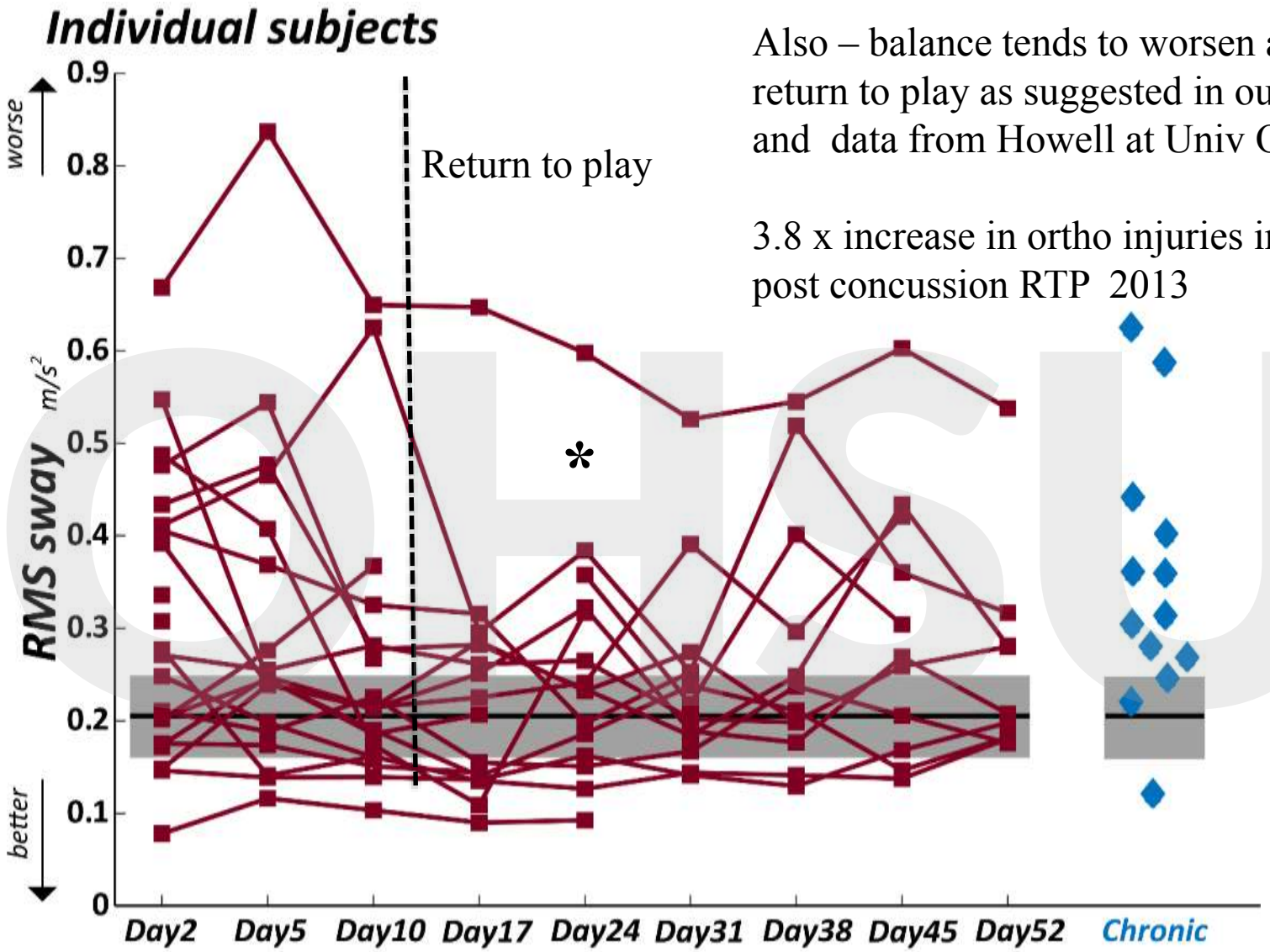
Instrumenting the BESS could best classify chronic concussion vs healthy





King LA, Horak FB, Mancini, Pierce D, Priest KC, Chesnutt JC, Sullivan P, Chapman JC. Instrumenting the Balance Error Scoring System for use with patients reporting persistent balance problems after mild traumatic brain injury. *Arch Phys Med Rehabil.* *2013 Nov 4.*

(Mancini et al., 2012, King et al 2013)



Also – balance tends to worsen after return to play as suggested in our data and data from Howell at Univ Oregon*

3.8 x increase in ortho injuries in 90 days post concussion RTP 2013

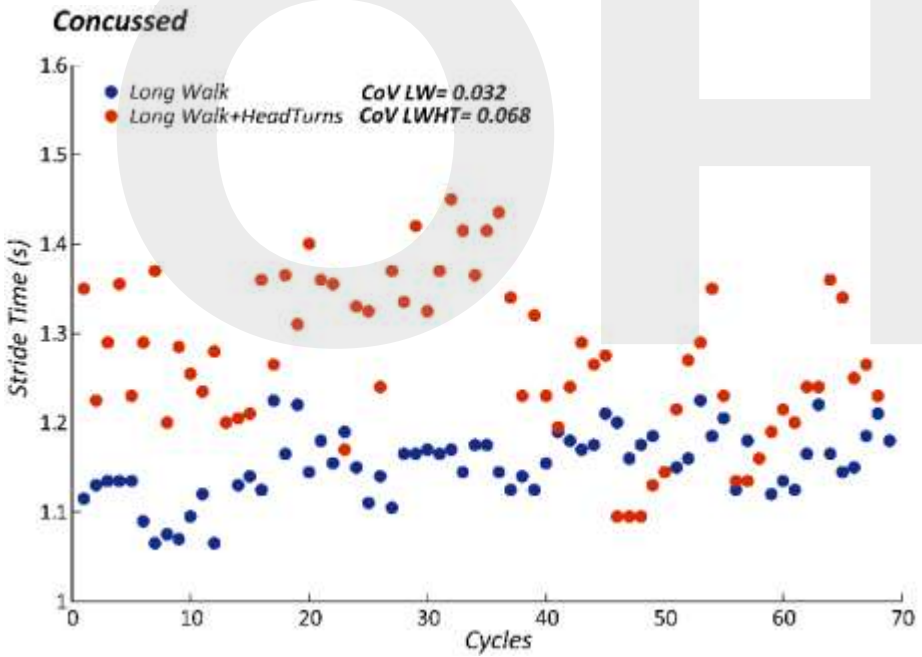
*King et al, 2014

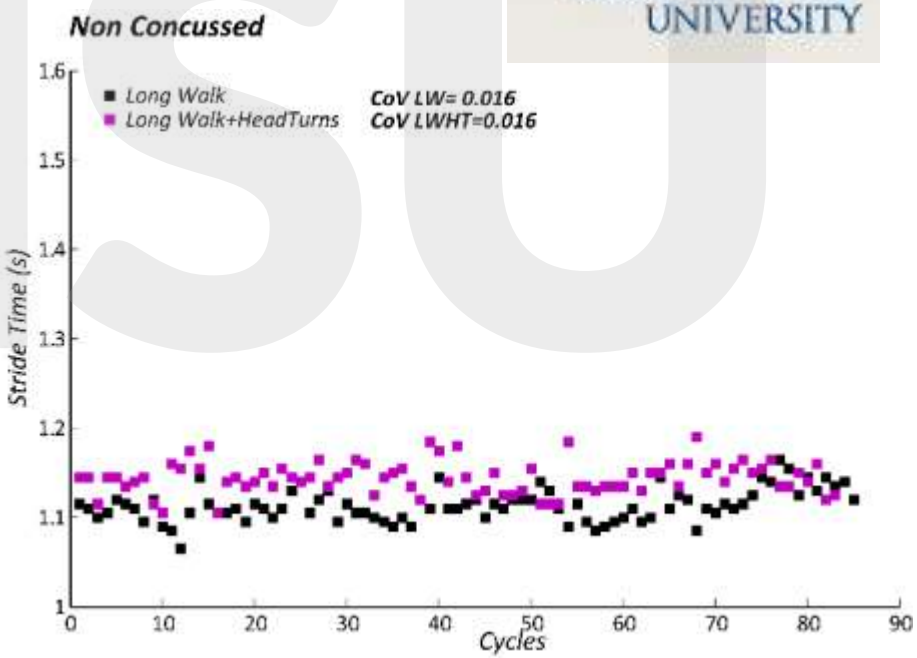
*Howell D. MS, Osternig L. Chou L. 2015 .

Dynamic balance during walking

Gait variability larger after concussion

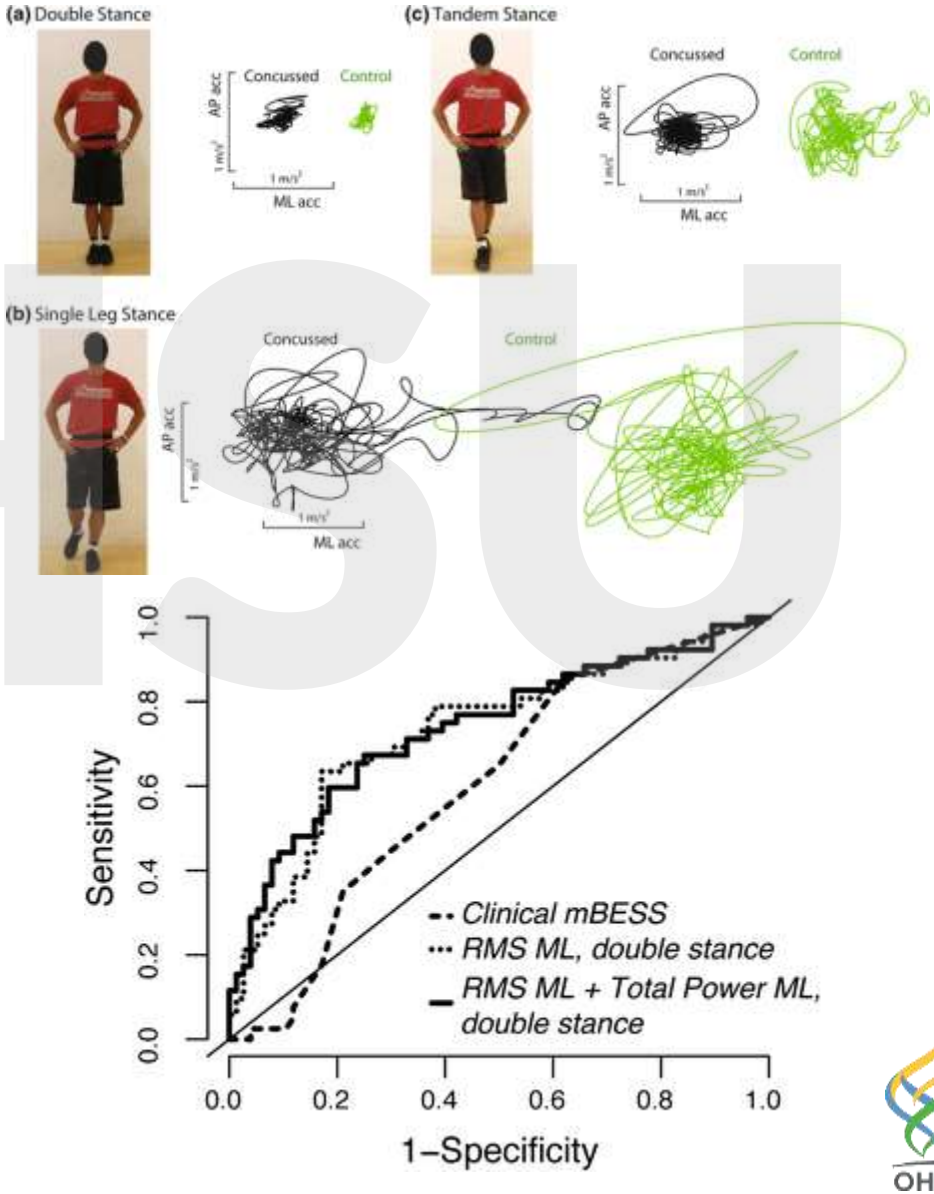
worse with dual task





Static balance: take home

Sensor with double limb stance on firm: best at diagnosing concussion and tracking recovery



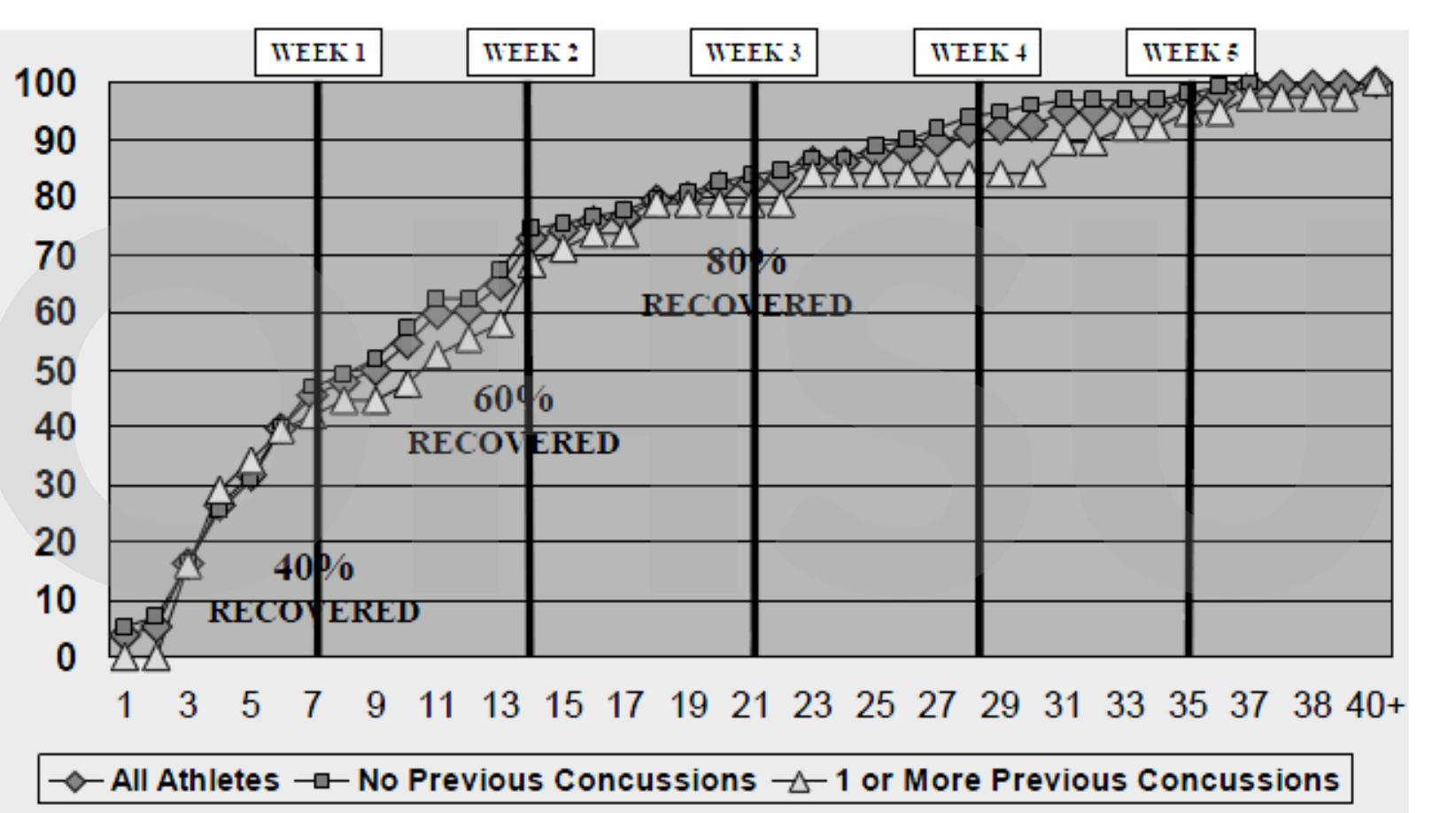
King LA et al; Ann Biomed Eng 2017

Active Management of Concussions: Return to Learn and Play

The Goal of Appropriate Treatment

- Minimize the duration of symptoms
- Return to play as soon as safely possible
- Avoid entirely the risk of second impact syndrome
- Minimize the rate of chronic post concussion syndrome

Concussion recovery: How long



n = 134 male football athletes

Collins et al; Neurosurgery 2006

Concussion prognostic Factors suggesting slower recovery

- Athlete pre-injury characteristics:
  - Previous concussions
  - Migraine (personal and family)
  - Vestibular or occular issues
  - ADD or learning issues
  - Genetics (apoE 4)
  - Age/ gender

- Am J Sports Med 399110:2311-2318

Concussion Prognostic Factors suggesting slower recovery

- Post concussion symptoms:
  - Early dizziness/ imbalance(7x risk >21 days)
  - Nausea and Vomiting
  - Diff concentrating and fogginess
  - Photo/ phonosensitivity

  - Early intervention seems to impact recovery

Am J Sports Med 399;110:2311-2318

“Rest or not to rest?”

- Recognize role of relative rest: avoid “cocoon” or “black box” theories
- “best evidence suggests complete rest exceeding 3 days is probably not helpful”
  - Silverberg. J Head Trauma Rehab. 2013
- Encourage return to some activity
  - ↓ mood disorders/social isolation
- Avoiding contact sports
  - Decreased reaction speed
  - Brain more vulnerable to injury , 2nd impact

Exercise and Concussion recovery

- Post concussion treadmill tests in first week are safe per Dr Leddy study
- Exercise tolerance associated with successful RTP- Leddy
- Improved aerobic fitness associated with fewer headaches, esp migraine

Aerobic Exercise: Buffalo Concussion Treadmill Test (BCTT) (Modified Balke protocol)

Provocative exercise test: help to determine if ready for RTP

- Protocol: Measure BP, HR and RPE
  - Treadmill: 3.6 mph, 0.0% incline
  - Minute 2: 3.6 mph, 1.0% incline
  - Minute 3: 3.6 mph, 2.0% incline
  - Minute 4: 3.6 mph, 3.0% incline
  - Keep going: ↑ 1.0% incline every min until:
    - Symptomatic (≥ 3 points)
    - Exhaustion (Borg 19/20 or 85% of age-predicted max HR)
- High inter-rater reliability (95%) and sensitivity (99%)

Leddy JJ et al 2013
Baker JG et al 2012

Vestibular Rehabilitation with Concussion is effective

Recommended by 5th Consensus statement on concussion in sport

Vestibular therapy + cervical PT vs sham

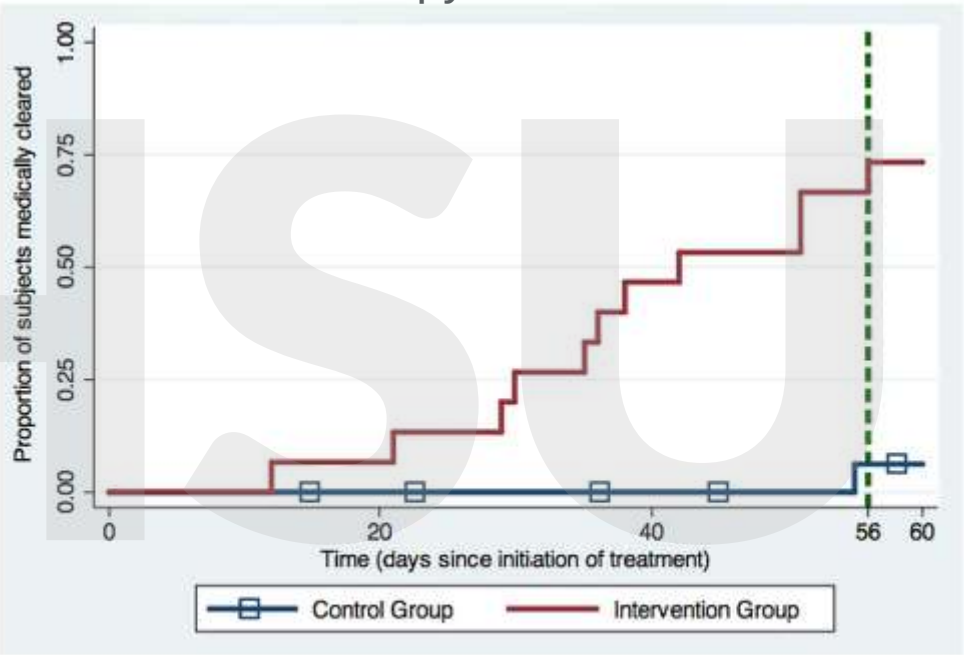
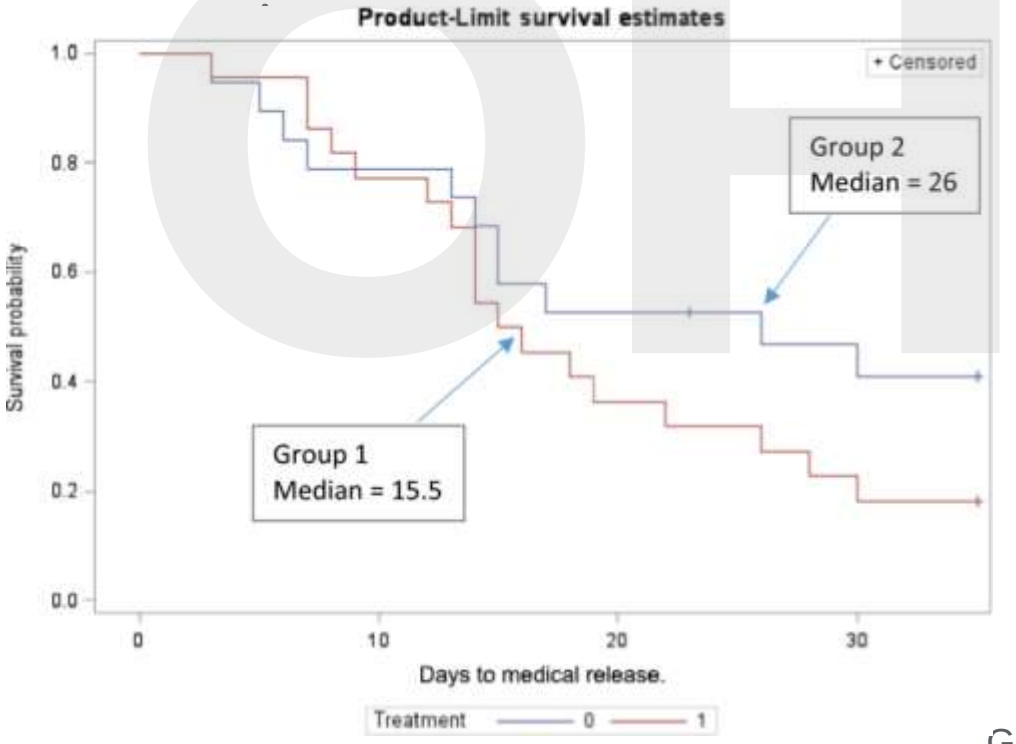


Figure 1 Proportion of patients medically cleared over time.

Schneider KJ et al; Br J Sports Med 2014
Alsalaheen BA et al; J Neurol Phys Ther. 2010
McCroy P, Meeuwisse W, Dvorak J et al; Br J Sports Med 2017

Early Physical Therapy in concussion is safe

- **PT:** 10 days post injury
  - Safe
  - Shortened recovery



- **Return to activity in kids within 7 days:** ↓ symptoms vs no activity
- **Aerobic exercise**
  - Buffalo protocol (treadmill) 1-9 days post injury **did not harm** patients

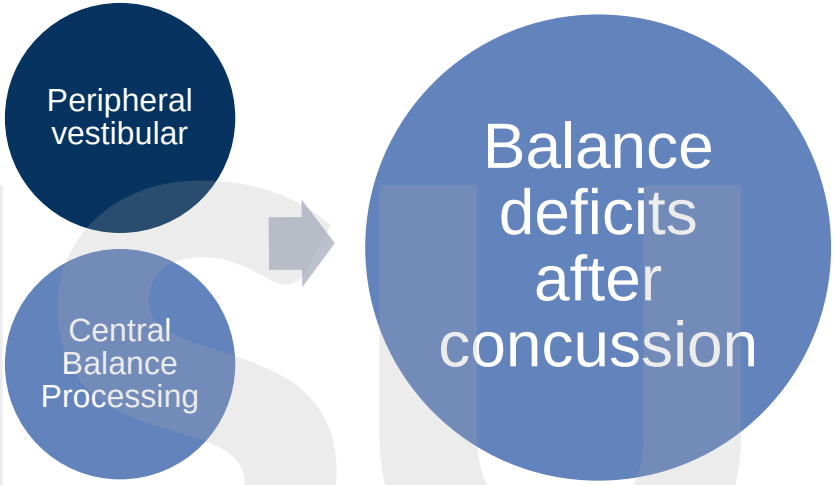
Grool AM et al; JAMA 2016
Reneker JC et al; Scand J Med Sci Sports 2017
Leddy et al; Clin J Sports Med 2018

Assessment and Rehabilitation of Central Sensory Impairments for Balance in mTBI

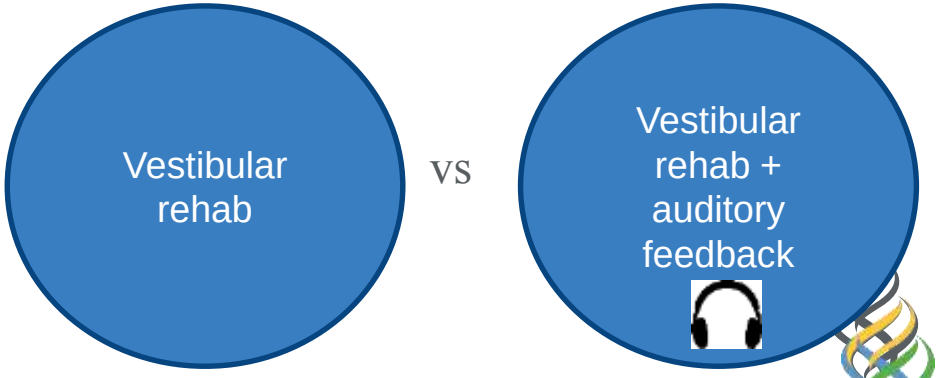
PI: Laurie A King, PT, Ph.D.

DOD Award: $2 million

Study Aim 1: To characterize the differences in sensory weighting between people with and without chronic mTBI



Study aim 2: To evaluate whether sensory weighting changes with rehabilitation



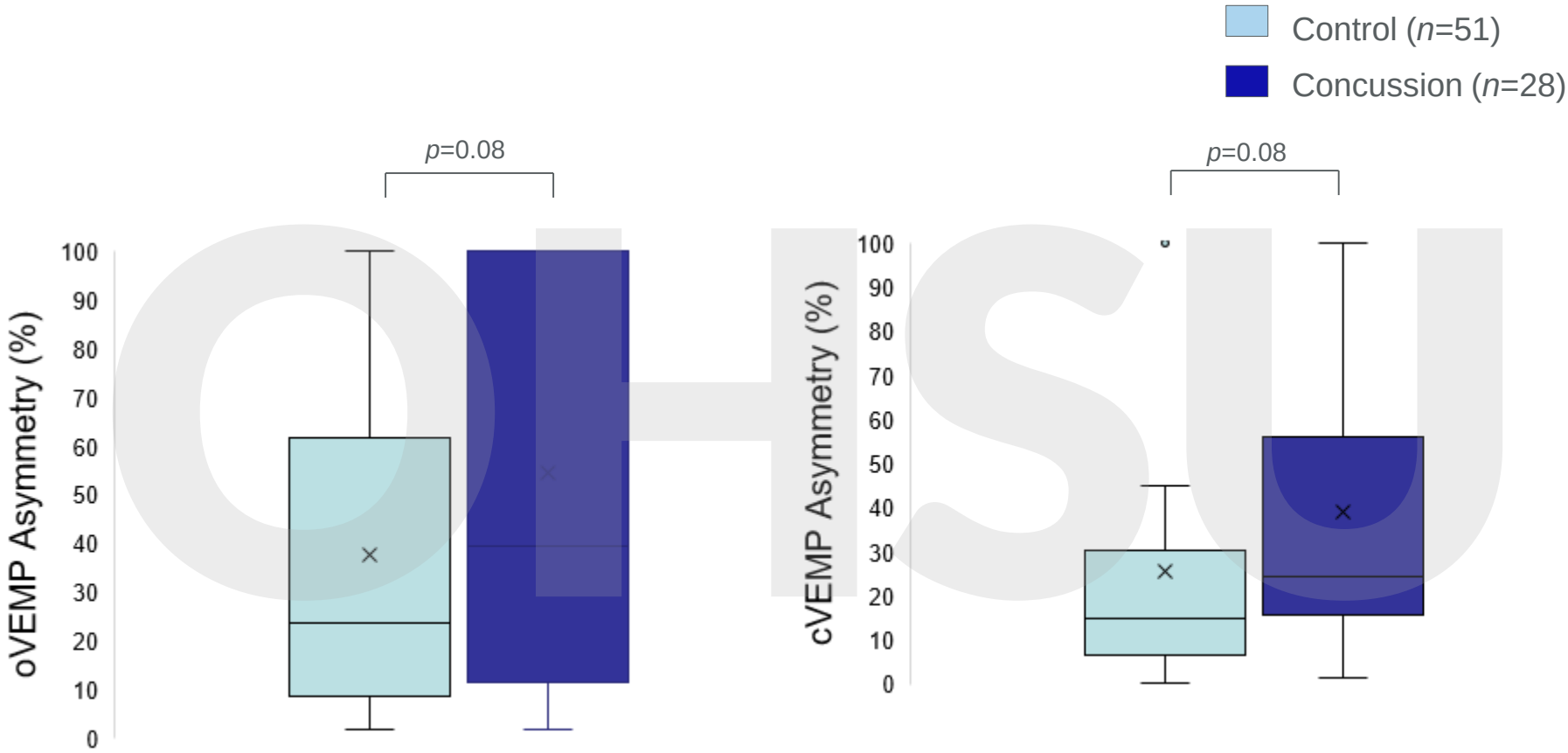
Fino PC et al; BMC Neurol 2017

Vestibular rehabilitation program – progressing in difficulty over 6 weeks

	Eyes Open				Eyes Closed			
	Feet Together (DS), Firm							
Static	Standing Still	Tossing Ball	Rotating Head (L/ R) Smooth Pursuit Gaze Stabilization Saccades	Bobbing Head (U/ D) Smooth Pursuit Gaze Stabilization Saccades	Standing Still	Rotating Head (L/ R)	Bobbing Head (U/ D)	
	Feet Together (DS), Foam							
	Standing Still	Tossing Ball	Rotating Head (L/ R)	Bobbing Head (U/D)	Standing Still	Rotating Head (L/ R)	Bobbing Head (U/D)	
Dynamic	**Tandem Gait, Firm**							
	Walking	Tossing Ball	Rotating Head (L/ R)	Bobbing Head (U/D)	Walking			
	Tandem Gait, Foam							
	Walking	Tossing Ball	Rotating Head (L/ R)	Bobbing Head (U/D)	Walking			
Bending	Chair	Side of Treadmill	Floor		Chair	Side of Treadmill	Floor	
Squatting	**Squat Firm**							
	Sit to stand (mini squat)	Lunge	Lunge onto unstable surface	Lunge + Twist	Sit to stand (mini squat)	Lunge	Lunge onto unstable surface	Lunge + Twist
	Squat Foam							
	Sit to stand (mini squat)	Lunge	Lunge onto unstable surface	Lunge + Twist	Sit to stand (mini squat)	Lunge	Lunge onto unstable surface	Lunge + Twist

(Fino, et al., 2017)

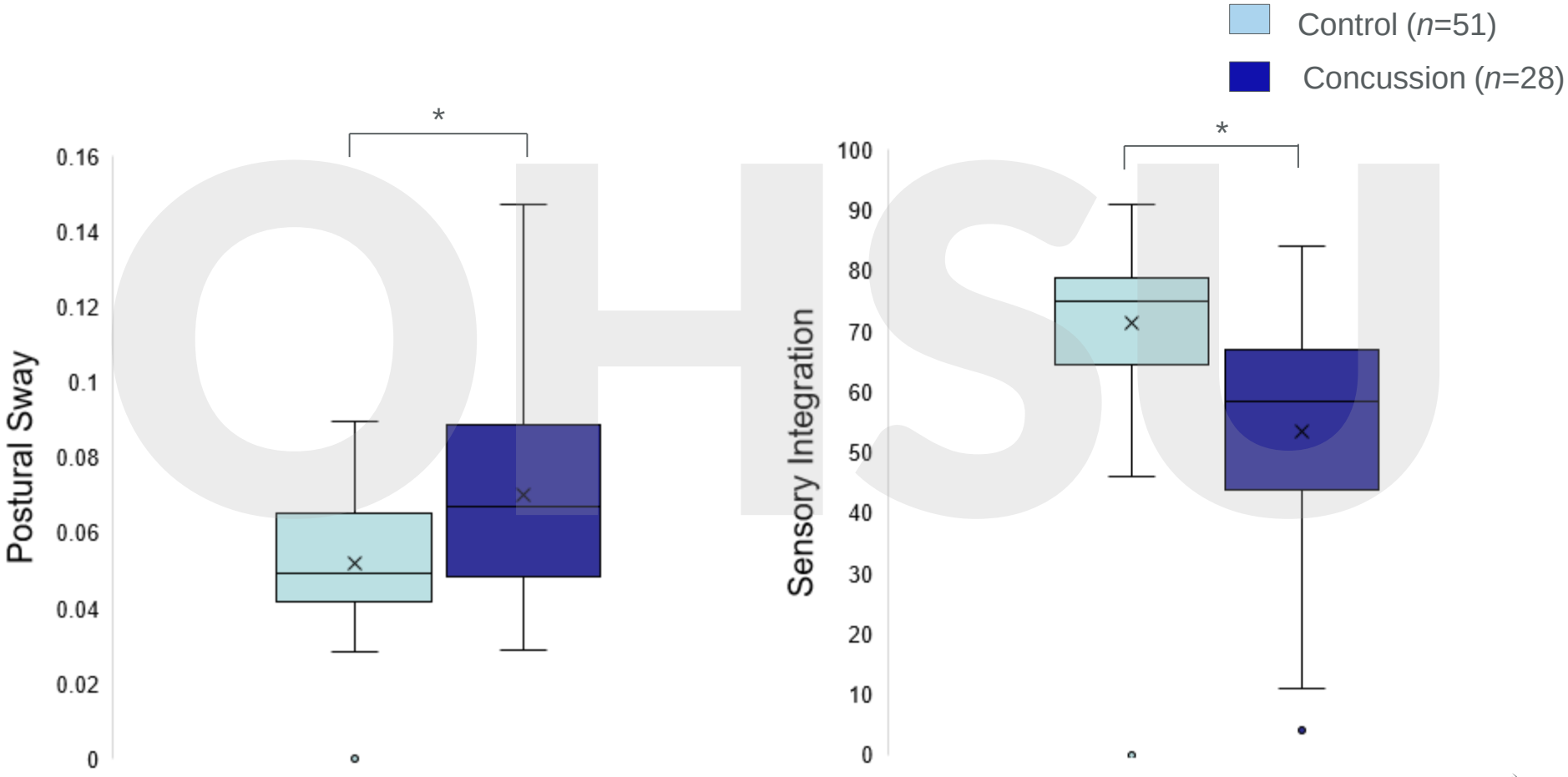
Results: No abnormal otolith function



- No difference in the amplitude of cVEMP or oVEMP ($p>0.05$)

OHSU

Results: Abnormal central control of balance post concussion



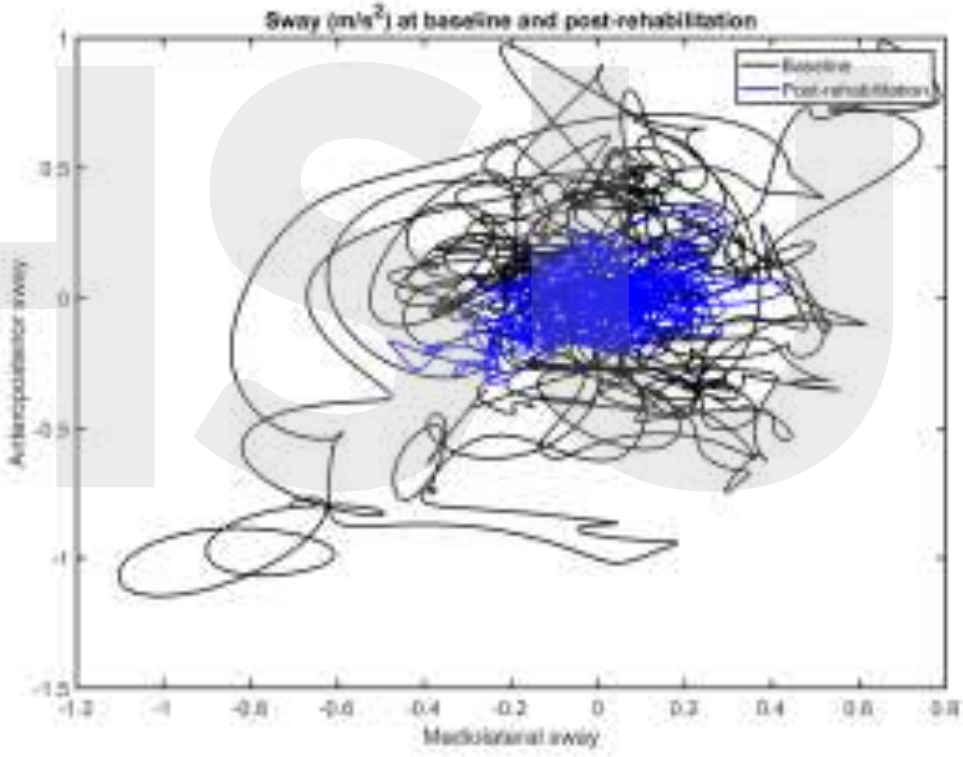
mBESS: Feet together, EC + Foam

Composite score of SOT

OHSU

Preliminary results:

Auditory biofeedback may be useful to augment real-time sensory feedback for balance



OHSU

Take homes

- Chronic mTBI:
  - Central dysfunction of vestibular system
  - No peripheral otolith dysfunction
- People with chronic mTBI improved!
  - Repetition/frequency higher in research protocol
- Outcome measures:
  - SCAT symptom checklist
  - SOT/CSMI

Rehabilitation of Complex TBI with Sensory Integration Balance Deficits: Can Early Initiation of Rehabilitation with Wearable Sensor Technology Improve Outcomes?

Log #PT160104
Award # W81XWH-17-1-0424

PI: Laurie A King, PT, Ph.D.

DOD Award: $4,652,124

Why early rehab?

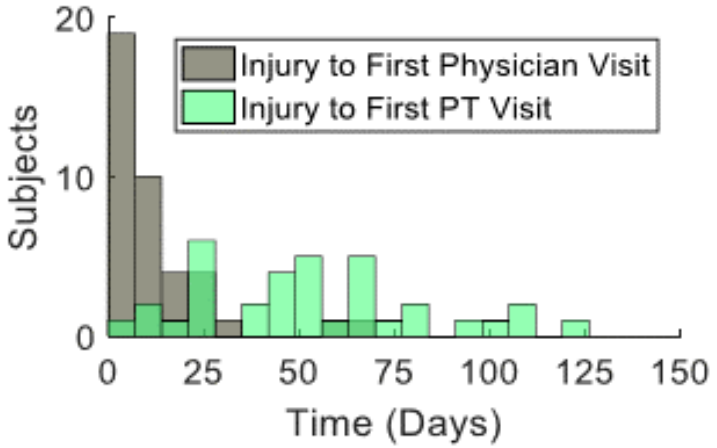
- Waiting can encourage maladaptive strategies
- Early promotes neuroplasticity
- After peripheral vestibular disorder: improved outcomes when treated early vs late
- Negative outcomes: hours post injury (not days) based on animal models

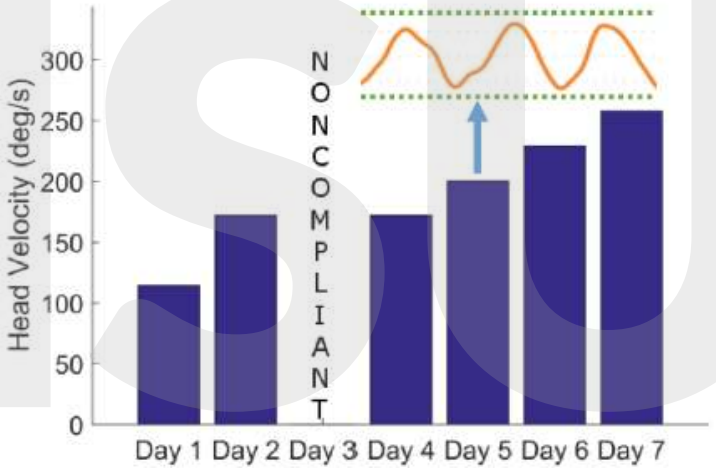
- **Early is the new Normal:**
  - **Early** mobilization in the ICU on mechanical ventilation improves LOS
  - **Early** (2 d) vs Delayed (9 d) rehab for muscle injury : faster RTP
  - Current model for neurological rehabilitation

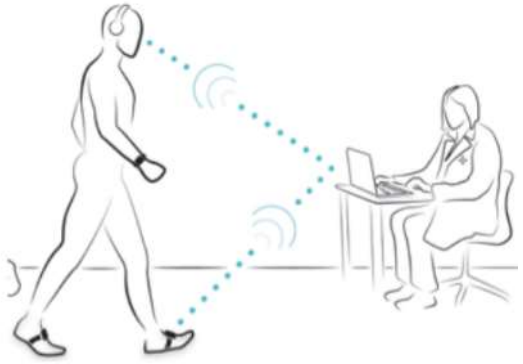
Bamiou DB et al Scand Audio 2000; Shen J et al; Brain Research 2016
Hashem MD et al; Respir Care 2016; Bayer et al; N Engl J Med 2017

Study Aims

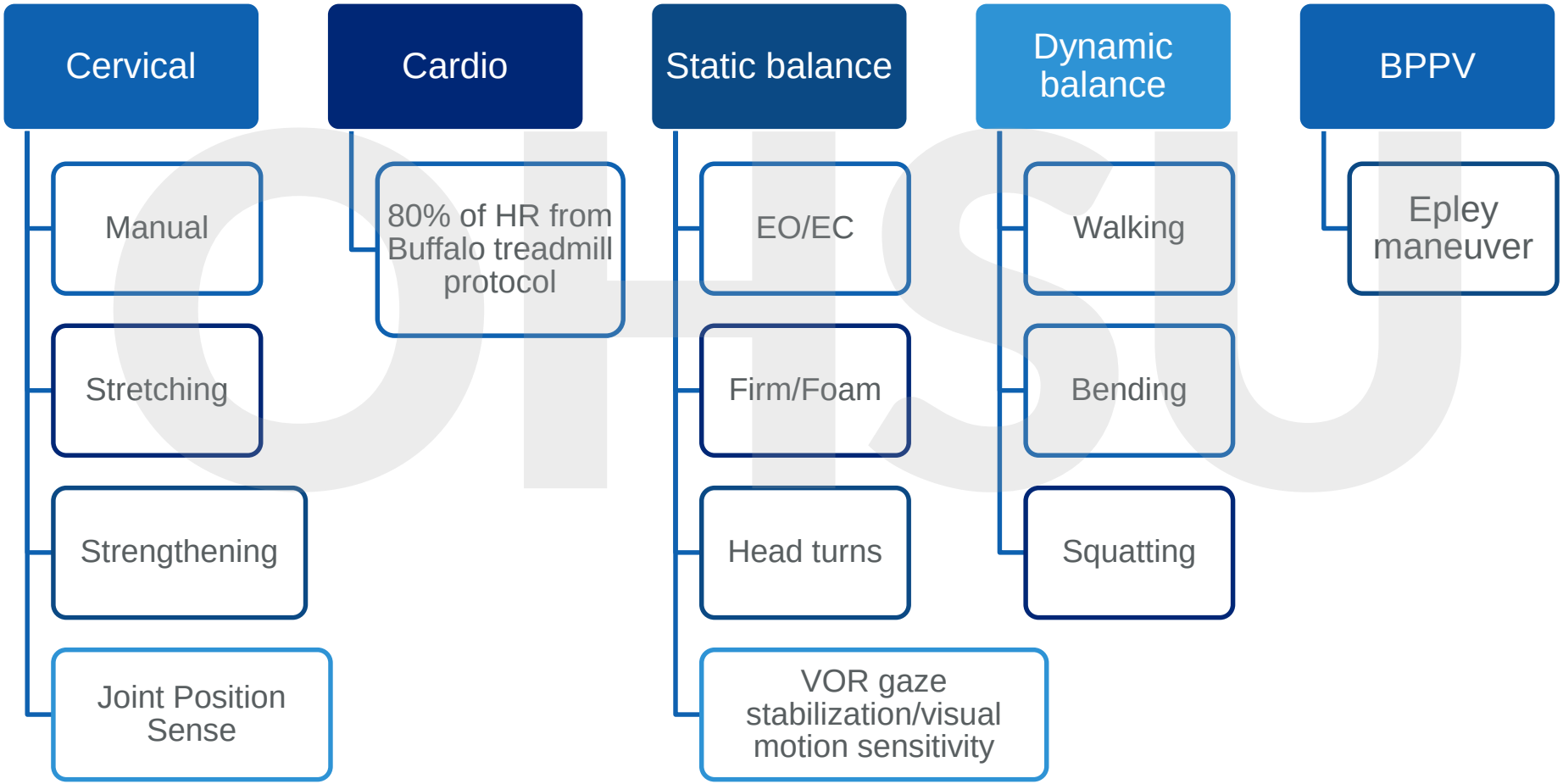
1. Does early rehab improve outcomes vs standard care?
2. Are patients doing their home program and are they doing it correctly?
3. Develop technology for PTs to get real time feedback on head/trunk motion







Protocol


Cervical
Manual
Stretching
Strengthening
Joint Position Sense
Cardio
80% of HR from Buffalo treadmill protocol
Static balance
EO/EC
Firm/Foam
Head turns
VOR gaze stabilization/visual motion sensitivity
Dynamic balance
Walking
Bending
Squatting
BPPV
Epley maneuver

Early Concussion Intervention: Study Overview

Population	Intervention	Comparison	Outcome
• 18-60 yo • < 12 wks from concussion	• Vestibular x 30 min • Cervical x 15 min • Cardiovascular (sub threshold) x 15 min	• “Early” vs “Standard” care • With and without home monitoring using sensors	• Buffalo treadmill • SCAT2 • VOMS • Instrumented BESS and walking tests • CSMI

OHSU

Contact Info

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Grants awarded for mTBI and Balance (OHSU: Neurology King Lab)

Grants

- NIH: Center for Translation of Rehabilitation Engineering Advances and Technology (TREAT)
  Title: Wearable Sensor to Detect Postural Instability in People after Concussion
  PI: Laurie King PT, Ph.D

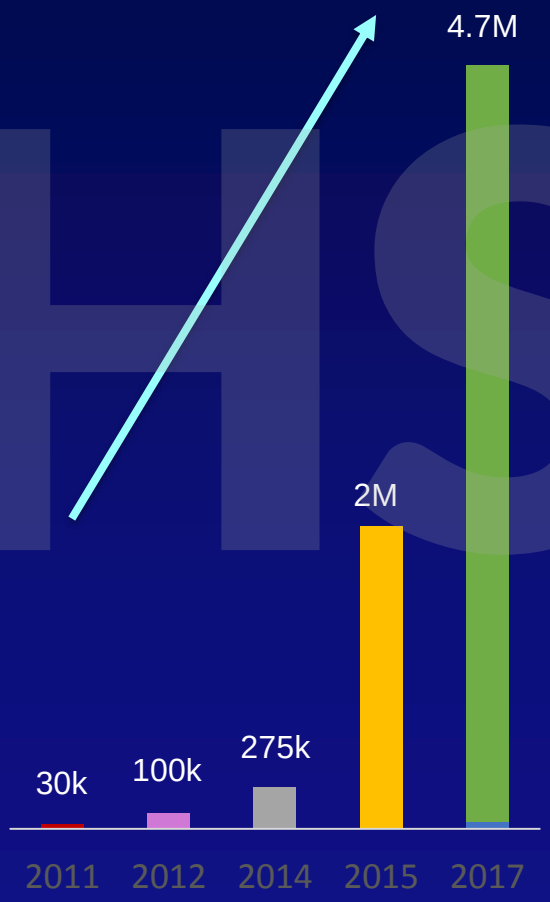
- OCTRI K22
  Title: Quantification of balance deficits after concussion; implications in return to play determination
  PI: Laurie King PT, Ph.D

- NIH R21
  Title: Wearable Sensor to Detect Postural Instability in People after mTBI
  PI: Laurie King PT, Ph.D

- Department of Defense
  Title: Assessment and Rehabilitation of Central Sensory Impairments for Balance in mTBI
  PI: Laurie King PT, Ph.D

- Medical Research Foundation
  Title: Perturbations and mTBI
  PI: Peter Fino PhD

- Department of Defense
  Title: Rehabilitation of Complex TBI with Sensory Integration Balance Deficits; Can Early Initiation of Rehabilitation with Wearable Sensor Technology Improve Outcomes?
  PI: Laurie King PT, Ph.D



Publications

▪Fino P.C., Parrington L., Walls M., Sippel E., Hullar T.E., Chesnutt J.C., King L.A. Abnormal turning and its association with self-reported symptoms in chronic mTBI. Journal of Neurotrauma 2017

▪Fino PC, Peterka RJ, Hullar TE, Murchison C, Horak FB, Chesnutt JC, King LA. Assessment and rehabilitation of central sensory impairments for balance in mTBI using auditory biofeedback: a randomized clinical trial. BMC Neurology 2017, 17(1):41.

▪King, L. A., Mancini, M., Fino, P. C., Chesnutt, J., Swanson, C. W., Markwardt, S., & Chapman, J. C.. Sensor-based balance measures outperform modified balance error scoring system in identifying acute concussion. Annals of Biomedical Engineering 2017 45(9) 2135-2145.

▪Haran, FJ, Slaboda, JC, King, LA, Wright, WG, Houlihan, D, & Norris, JN. Sensitivity of the Balance Error Scoring System and the Sensory Organization Test in the Combat Environment. Journal of Neurotrauma, 2015 33(7);705-11

▪King LA, Horak FB, Mancini, Pierce D, Priest K, Chesnutt, Chapman J. Instrumenting the balance error scoring system for use with patients reporting persistent balance problems after mild traumatic brain injury. Archives of Physical Medicine and Rehabilitation 2014 95(2):353-9

▪Fino P.C., Parrington L., Pitt W., Martini D.N., Chesnutt J., Chou L., King L.A. (Under Review). Detecting Gait Abnormalities After Concussion or Mild Traumatic Brain Injury: A Systematic Review of Single-Task, Dual-Task, and Complex Gait.

•Parrington L, Fino PC, Swanson C, Murchison CF, Chesnutt JC, King LA; Longitudinal assessment of balance and gait following concussion in college athletes; In preparation.

•Parrington L, Fino NF, Fino PC, Murchison CF, Chesnutt JC, King LA. Inflection points in longitudinal models: Tracking recovery and Return to Play following concussion; submitted and under review

▪Fino PC, Wilhelm J, Parrington L, Stuart S, Chesnutt JC, King LA. Horizontal head turns after concussion: insight from inertial sensors. Archives of Physical Med and Rehabilitation; In preparation

Balance Disorders Laboratory

Funding: This work was supported by the Assistant Secretary of Defense for Health Affairs under Award No.W81XWH-15-1-0620. Opinions, interpretations, conclusions and recommendations are those of the author and are not necessarily endorsed by the Department of Defense.

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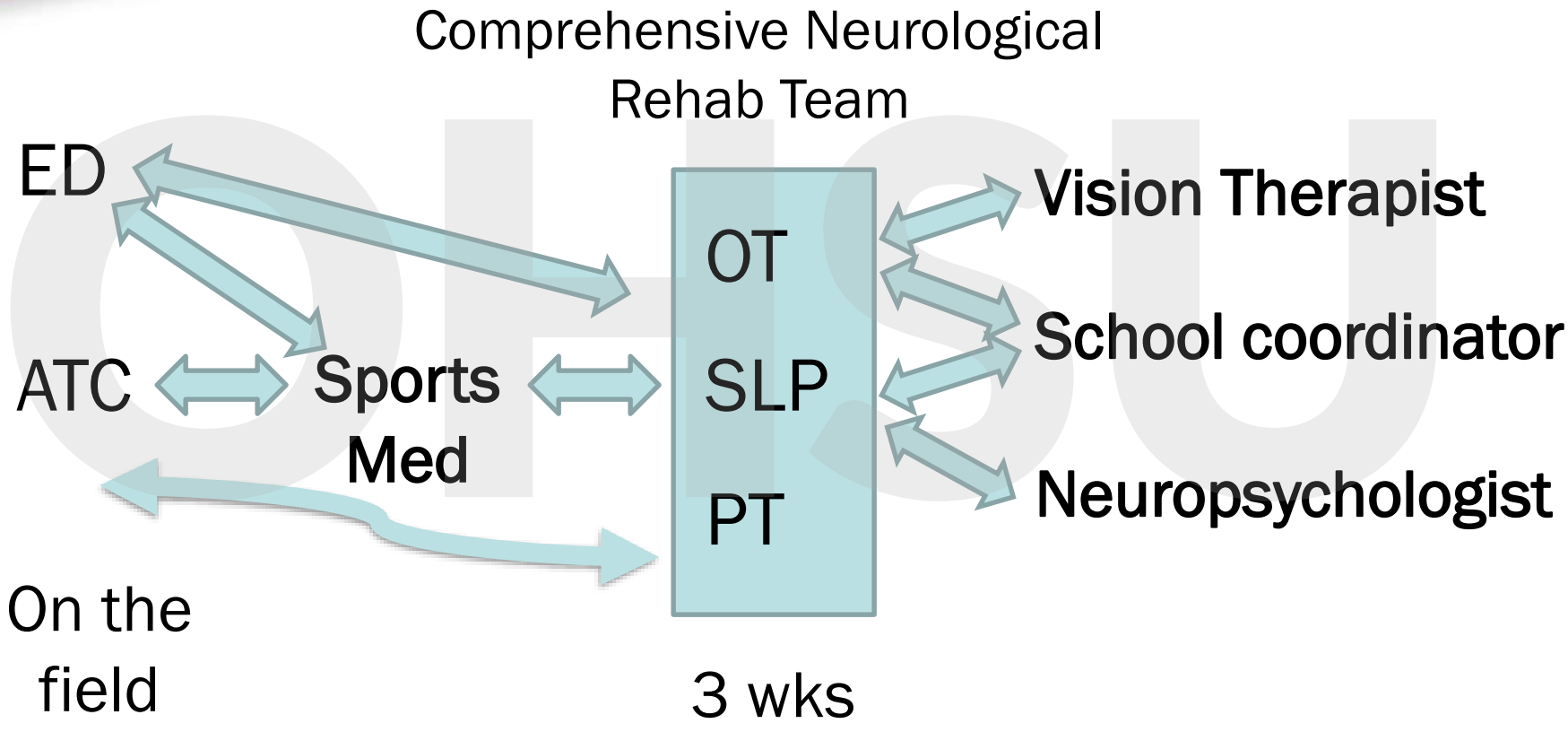
Interdisciplinary approach: OHSU Model



OREGON HEALTH & SCIENCE UNIVERSITY

OHSU Concussion Rehab Team

A. Speech -language pathologist: for evaluation and treatment to address cognitive and executive function and school and work issues.

B. Physical therapy: for vestibular therapy and neck and associated orthopaedic issues and exercise testing and prescription.

C. Occupational Therapy: for visual and functional therapy , s sensory integration/ overload and driving evaluations.

D. Concussion Coping Clinic and Support Group

This is on the 1st floor of OHSU Center for Health and Healing.

Please call 503-494-3151 to schedule an appointment but this will likely need to be approved by your insurance

Return to Play Protocol

Stage	Aim	Activity	Goal
1	Symptom limited activity	Daily activities that do not increase symptoms (after about 1-2 d rest)	Gradual re-introduction of work/school activities
2	Light aerobic exercise	Walking or stationary bike. No resistance training	Increase in HR <70% max Walk, jog, exercise bike
3	Sport-specific exercise	Running/skating drills; no head impact activities	Add movement
4	Non-contact training drills	Harder training drills (passing drills). Start progressive resistance training	⇧Exercise, coordination and cognitive load add wt lifting, passing, plays
5	Full contact practice	*Requires medical clearance; can participate in normal training activities	Restore confidence and asses functional skills by coaching staff/ ATC
6	Return to sport	Normal unrestricted game play	

McCrory P, et al; Br J Sports Med. 2017

*Start with 24-48 hrs of rest before initiating stage 1
*Minimum 24 hrs per stage

OSAA Concussion Return to Play Form

Oregon School Activities Association
25200 SW Parkway Avenue, Suite 1
Wilsonville, OR 97070
503.682.6722 FAX 503.682.0960 http://www.osaa.org

CONCUSSION – RETURN TO PARTICIPATION MEDICAL RELEASE

Student Name: _____ **Date of Birth:** ___/___/___ **School/Grade:** _____

Date of Injury: ___/___/___ **Sport/ Injury Details:** _____

At this time, the student is:
- ☐ symptom-free at rest
- ☐ symptom-free at exertion
- ☐ scoring within a normal range on ImPACT
- ☐ NOT symptom-free at rest
- ☐ NOT symptom-free at exertion
- ☐ NOT scoring within a normal range on ImPACT

When ImPACT is utilized, please either attach or allow access to baseline and post concussive scores with percentiles.

Comments: _____

Completed by (Printed name): _____ Signature: _____ Date: _____

☐ Registered Athletic Trainer ☐ Coach ☐ Athletic Director ☐ Other: _____

Graduated, Step-wise Return-to-Participation Progression

1. **No activity**: Complete rest, both physical and cognitive. This may include staying home from school or limiting school hours and/or homework as activities requiring concentration and attention may worsen symptoms and delay recovery.
2. **Light aerobic exercise**: Walking or stationary bike at low intensity; no weight lifting or resistance training.

Before progressing to the next stage the student must be healthy enough to return to school full time

3. **Sport-specific exercise**: Sprinting, dribbling basketball or soccer; no helmet or equipment, no head impact activities.
4. **Non-contact training**: More complex drills in full equipment. Weight training or resistance training may begin.
5. **Full contact practice**: Participate in normal training activities.
6. **Unrestricted Return-to-Participation/full competition**. (**Earliest Date of Return-to-Participation**: _____)

The student should spend a minimum of one day at each step. If symptoms re-occur, the student must stop the activity and contact their trainer or other health care professional. Depending upon the specific type and severity of the symptoms, the student may be told to rest for 24 hours and then resume activity one-step below where he or she was when the symptoms occurred. ***Graduated return applies to all activities including sports and PE classes.***

This section to be completed by Physician/Health Care Professional:

☐ Student **may NOT return** to any sport activity until medically cleared.

☐ Student should **remain home from school** to rest and recover with a projected return date _____

☐ Please **allow classroom accommodations,** such as extra time on tests, a quiet room to take tests, and a reduced workload when possible.

Additional Recommendations: _____

☐ Student **may begin graduated return at stage circled above.** If symptom free at rest and with graded exertion, can return to participation on date above.

☐ Student is now **cleared for full contact practice/participation:** symptom free at rest and exertion and has completed a graduated Return-to-Participation protocol.

Physician/Health Care Professional Signature: _____ **Date:** _____

Physician/Health Care Professional Name/Title: _____ **Phone:** _____

Per OAR 581-022-0421 "Health Care Professional" means a Physician (MD), Physician's Assistant (PA), Doctor of Osteopathic (DO) licensed by the Oregon State Board of Medicine, nurse practitioner licensed by the Oregon State Board of Nursing, or Psychologist licensed by the Oregon Board of Psychologist Examiners.

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Physician/Health Care Professional Name/Title: _____**Phone**:_____

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Return to Academic Plan

1. **RECOGNIZE:**
   Concussion management team identifies student's concussion and informs teachers

2. **REMOVE/REST**:
   Students remain home for 2 days or more with physical and cognitive rest

3. **REFER** :
   Students suspected of sustaining a concussion must be evaluated and cleared by a properly trained medical professional.

4. **RETURN :**
   Develop return to academic plan with educational accommodations with modified environment and work load. Consider freezing grades early and be flexible with transitions. **Back to school before athletics!**

Return to Academics after Concussion

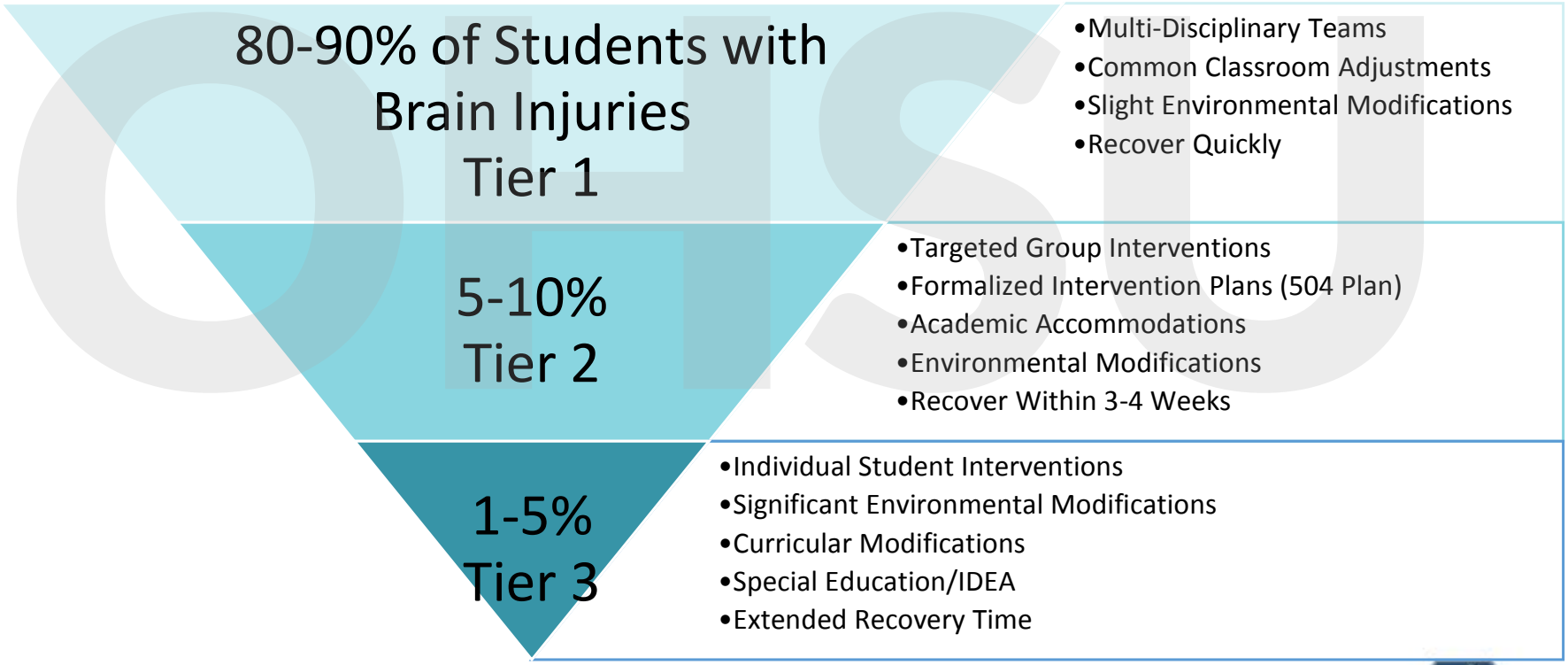
When students have symptoms after a concussion they may need a gradual return to their pre-injury academic load. This progression can speed recovery and support the student's return to a full academic load. Important things to remember:

- The stages are flexible based on the student's tolerance to school activities.
- Depending on symptoms, a student may start at any step and remain at each step as-long-as needed.
- If symptoms worsen, the student should return to the previous step.
- Daily check-ins with the student regarding how they are tolerating school is recommended.
- Depending on symptoms, some students can begin limited physical activity early after injury.

Stage	Suggested Accommodations	Criteria for Progression
Rest Limited mental activity	Limited mental exertion (computer, texting, video games, or homework), no driving	30 minutes of mental exertion without symptom exacerbation
Part-time school with accommodations	Accommodations based on symptoms (e.g., shortened day/schedule, built-in breaks, no significant classroom or standardized testing)	Full day of school with accommodations
Full-time school with accommodations	Accommodations based on symptoms (e.g., shortened day/schedule, built-in breaks, no significant classroom or standardized testing)	Handles all class periods in succession without symptom increase.
Full pre-injury academic load	Complete return to pre-injury status	NA

CBIRT- www.osaa.org Return to Learn

A school-wide academic accommodation protocol for students with concussions or brain injuries can be effectively implemented in most schools using the following progression.



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Acute Concussion Evaluation (ACE)
Care Plan

Gerard Gioia, PhD[1] & Micky Collins, PhD[2]
[1]Children's National Medical Center
[2]University of Pittsburgh Medical Center

Patient Name_____
DOB: _____ Age:_____
Date:_____ ID/MR#_____
Date of Injury:_____

You have been diagnosed with a concussion (also known as a mild traumatic brain injury). This personal plan is based on your symptoms and is designed to help speed your recovery. Your careful attention to it can also prevent further injury.

Rest is the key. You should not participate in any high risk activities (e.g., sports, physical education (PE), riding a bike, etc.) if you still have any of the symptoms below. It is important to limit activities that require a lot of thinking or concentration (homework, job-related activities), as this can also make your symptoms worse. If you no longer have any symptoms and believe that your concentration and thinking are back to normal, you can slowly and carefully return to your daily activities. Children and teenagers will need help from their parents, teachers, coaches, or athletic trainers to help monitor their recovery and return to activities.

Purpose of Care Plan: Guide recovery , Educate, Manage exertional and school activity

Educational resources: State TBI Teams

Develop concussion education programs and return to academic programs, and assist with 504 plans if needed.

Call : 541-346-0597 or Email: **www.ocamp.org**

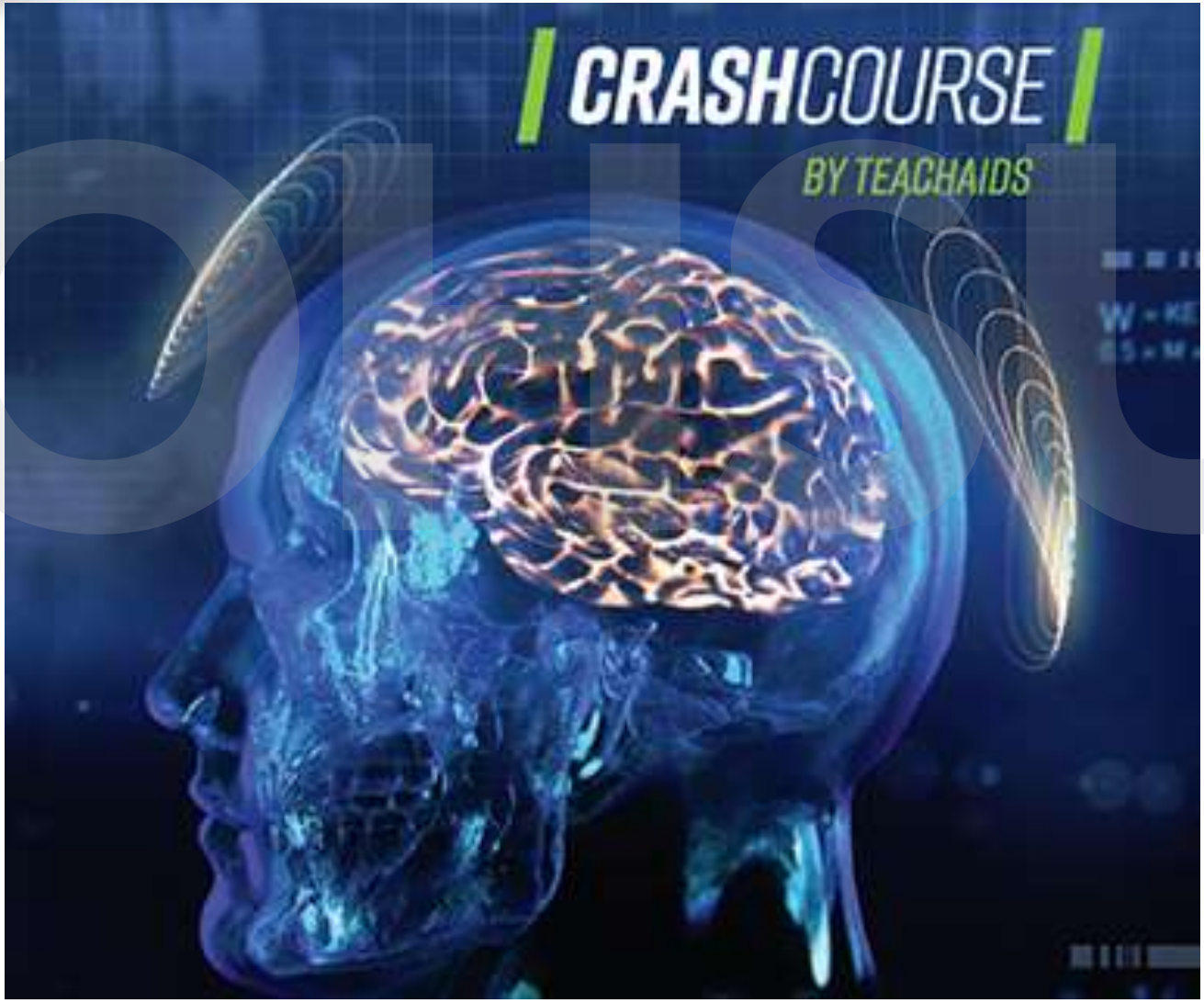
http://brain101.orcasinc.com

The Effectiveness of a Web-Based Resource in Improving Post-concussion Management in High Schools. Glang AE, Koester MC, Chesnutt JC, Gioia GA, McAvoy K, Marshall S, Gau JM, *Journal of Adolescent Health* , Volume 56, Issue 1 , 91 – 97, Jan 2015.

Crash Course- new for concussion education

What is CrashCourse?

https://teachaids.org/for-concussions/crashcourse/



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USA FOOTBALL- Heads Up program

Video on OSAA website- www.osaa.org

- OSAA- Concussion guidelines and return to learn info from CBIRT/ OCAMP
- www.osaa.org/health-safety

CDC Concussion Tool Kit

- Videos and Educational/ media programs

www.cdc.gov/ncipc/tbi/Coaches_Tool_Kit.htm

Summary

- Must improve early identification & diagnosis
  - Coach, athlete, parent, Correction officer, medical education
- Careful individualized clinical assessment and tracking from time of injury
  - SCAT5
  - Neuropsychological Testing (Impact, Axon, or full)
- Interdisciplinary Team- OT, PT, SLP
- Implement active treatment in home & school
  school accommodations, 504 plan, OCAMP.org
  Max's Law Implementation Guide- download
- Free coaches education: You too can take this…
  www.osaa.org/healthandsafety/concussion.asp

OHSU Concussion Team

Sports Medicine Doctors

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Melissa Novak D.O.
Rachel Bengtzen M.D.
Doug McKeag, M.D.
Sean Robinson, M.D.
Carol Federiuk, M.D.
Ryan Norton, M.D

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Kristin Moore, PT, DPT
Bill Rubine, MSPT
Jeff Schlimgen, MSPT, NCS
Marvin Smith, PT, DPT
.Kate Scanlan, PT, DPT, NCS
Amy Woods, PT, DPT
Margaret McReynolds, PT, M.S.ED

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Orthopeadics / Spine
Family Medicine
Neurology Peds/ Adult
Anesthesia/ Pain Center
Neurosurgery
Psychiatry
Trauma
ENT/ vestibular
Ophthalmology
Emergency Med
Internal Medicine
Pediatrics
Radiology

Neuro-psychology

Sara Walker, PhD
Muriel Lezak, PhD
Leeza Maron, PhD
Bonnie Nagel, PhD
Trevor Hall, PhD
James Carson, PhD
Tyler Duffield, PhD

Occupatioanl / Visual Therapy

Rosanne Yee, OTR-L
Anne-Marie Banasky, OTR-L, CHT
Kelly Dunbar, OTR-L, CHT
Kyla Laraway, OTR-L, OTD

Speech/ Cognitive Therapy

Haley Landau, MS, CCC-SLP
Kristin Knight, MS, CCC-SLP

Certified Athletic Trainers

Ryan Rockwood, ATC-R
Kayla Ward, ATC-R

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Thank You

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2019 OHSU TBI Symposium: Dec 13-14